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Cybertherapy

Internet and Virtual Reality as Assessment and Rehabilitation Tools for Clinical Psychology and Neuroscience

Editors:
G. Riva
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PREFACE

A Japanese warrior was captured by his enemies and thrown into prison. That night he was unable to sleep because he feared that the next day he would be interrogated, tortured, and executed. Then the words of his Zen master came to him, "Tomorrow is not real. It is an illusion. The only reality is now." Heeding these words, the warrior became peaceful and fell asleep.

Suler, 1997,
http://www.rider.edu/suler/zenstory/present.html

The "Psychology of Cyberspace" [1, 2] and related fields, such as the "Psychology of the Internet" [3] and the "Psychology of Internet Behavior" [4], are new areas of study that have attracted psychologists in various specializations—clinical, counseling, educational, organizational, cognitive, social, and more—as well as researchers in other disciplines, among them communication, medicine, sociology, education, psychiatry, social work, and nursing.

These new areas have developed rapidly, accumulating knowledge and making innovative assertions and propositions that can generally be divided into two major directions: understanding the influence and impact of human experience with computers in cyberspace, on the one hand, and applying psychological procedures through (or with the help of) computers and the Net, on the other [5]. A vast majority of the psychological applications have been clinical and clinical-related and are considered a significant advancement in this field [6].

In being an extremely interdisciplinary field of study, psychology of cyberspace exemplifies unique cooperation among various distinctive professions: software programmers, computer and Web designers, and computer engineers at one end, and psychologists of different specialties at the other. The results of this collaboration have created exemplary works, represented by the VEPSY Updated (http://www.cybertherapy.info) project collaborators in the present collection of chapters.

The combination of ergonomics (human engineering), software engineering and programming, and computer design and graphics, on the one hand, and psychological and medical interventions, on the other, brings about innovative perspectives and effective implementations, whose aim is to serve humanity by offering better vehicles with which to heal physical and emotional deficiencies and injuries.

Although the projects presented in this volume represent significant breakthroughs, in the sense of creatively exploiting new technologies to attend to human miseries, further work is still required to fill the gap existing between the conceptualization of the cybertherapy experience and the actual implementations. As conceptualized and well presented by Mantovani [7] and Riva [8], interpersonal communication in virtual

environments, though problematic and often erroneous, constitutes an efficient basis for interpersonal relationship. In Riva's [9] words, "Communication is as the outcome of a complex coordinated activity, an event that generates conversational space within the weave of personal and social relationships. Thus, communication is not only—or not so much—a transfer of information, but also the activation of a psychosocial relationship, the process by which interlocutors co-construct an area of reality. In CMC this happens inside a rather special kind of container – cyberspace - that tends to rarefy the structural and process features of communication" (pp. 595-596).

This interpersonal relational basis - so central to human existence and functioning - seems to be missing from some of the actual cybertherapy applications, thus potentially limiting the implementation of more effective interventions. As criticized by Jacobson [10] in the context of the concept of "presence", human experience consists qualitatively of more than a physical environment, information received by the senses, and information processed by the brain; it includes, too, psychologically based dynamics, as evident in textual communications in virtual environments. In other words, as a clear touching point between body and mind, it seems that the "mind" aspect has been downplayed, compared with the "bodily" aspects. Thus, a further development of the current cybertherapy position will be an increased focus on the *relational factor* between therapists and patients as a significant therapeutic element of the clinical process. A better focus on this issue, as advocated by Riva and Galimberti [11, 12] in relation to conceptualizing cyberspace in general, will probably produce more targeted interventions.

Another point, related somewhat to the previous one, refers to the nature of the clinical interventions presented in this collection. Not surprisingly, three out of four of the therapeutic techniques discussed here are based on, or related to, the Cognitive-Behavioral Model (CBM). In fact, this approach has not only been found to be effective in treating numerous behavioral problems [13], but also can be translated relatively easily into computerized intervention programs. Notwithstanding the relevancy, effectiveness, and legitimacy of CBM to treat psychological problems, the understanding and exploiting of the client's personal dynamics - consisting of needs, desires, frustrations, conflicts, daydreams, emotions, and so on – are critical issues for an effective therapy. Thus, a more flexible, open, comprehensive, and eclectic approach might produce more effective cybertherapy tools. Some processes that are typical of and unique to human experience in synthetic environments, such as the powerful impact of the online disinhibition effect [14] and the process of transference in cyberspace [15], actually call for differently oriented therapeutic procedures to complement cognitive-behavioral interventions.

All in all, the current volume contributes significantly to the cumulative knowledge of emerging psychotherapy and the psychology of virtual environments. The writings in this book are evidence of apparent science fiction just two decades ago becoming scientific reality today. Specifically, what many psychologists once considered futuristic therapy is now a clinical actuality. Though paradoxical, and perhaps clichéd, the future is present, at least in the human mind. Like the Japanese warrior, we might profit tremendously from the gifts of the future by concentrating on and experiencing the state-of-the-art present—and thereby avert professional avoidance caused by fear of the unknown future.

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INTRODUCTION

Our observations suggest that working online is only suitable for therapists who have been specifically trained in the use of the powerful and yet challenging medium. As Internet usage continues to grow, and becomes integrated into our daily lives, newly trained therapists as well as experienced (f2f) therapists will increasingly seek to develop online practices. They will need to concentrate— through graduate training and also continuing education—on developing the skills and understanding which will promote "best practice" when engaging in online clinical work as a mental health professional.

Fenichel, Suler, Barak et al., 2002

Telehealth means "medicine at distance" where "medicine" includes not only medical activities - involving ill patients - but also public health activities - involving well people. In other words telehealth is a process and not a technology, including many different health care activities carried out at distance.

Since the development of methods of electronic communication clinicians have been using information and communication technologies for the exchange of health-related information: Telegraphy - signaling by wires - telephony, radio and television has been used for distance medicine since mid 19th century. However, rapid and far-reaching technological advances are changing the ways in which people relate, communicate, and live. Technologies that were hardly used a few years ago, such as the Internet, e-mail, video teleconferencing and shared virtual reality are becoming familiar methods for modern communication.

Health care is one of the areas that could be most dramatically reshaped by these new technologies. Distributed communication media could become a significant enabler of consumer health initiatives. In fact they provide an increasingly accessible communications channel for a growing segment of the population. Moreover, in comparison to traditional communication technologies, shared media offer greater interactivity and better tailoring of information to individual needs.

Cybertherapy, the integration of and telehealth technologies with the Internet and shared virtual reality, is the next logical step. Although cybertherapy is a branch of telehealth, it is differentiated in several important ways: telehealth to date has been largely non-Internet based and has been characterized by point-to-point (e.g., T1) and dial-up (e.g., telephone, ISDN) information exchange. Cybertherapy, on the other hand, is more accessible due to its increasingly affordable ability to communicate through a common set of standards and across operating systems.

In general, there are two reasons why cybertherapy is used: either because there is no alternative, or because it is in some sense better than traditional medicine. In this sense

telehealth has been used very successfully for optimizing health services delivery to people who are isolated due to social and physical boundaries and limitations. Nevertheless, the benefits of cybertherapy, due to the variety of its applications and their uneven development, are not self-evident. However, the emergence of cybertherapy is supporting the cost-effectiveness of certain applications, such as assessment, rehabilitation and therapy in clinical psychology and neuroscience. Its key advantage is the possibility of share different media and different health care tools in a simple to use and easily accessible interface.

To date, some cybertherapy applications have improved the quality of health care, and later they will probably lead to substantial cost savings. However, cybertherapy is not simply a technology but a complex technological and relational process. In this sense, clinicians and health care providers that want to successfully exploit cybertherapy need a significant attention to clinical issues, technology, ergonomics, human factors and organizational changes in the structure of the relevant health service.

The goal of this volume is to analyze the processes by which cybertherapy applications will contribute to the delivery of state-of-the-art health services. Particular attention is given to the clinical use of virtual reality technology. The starting point of this overview are the clinical results coming from the European Union VEPSY Updated - Telemedicine and Portable Virtual Environments for Clinical Psychology - research project (http://www.cybertherapy.info).
More specifically, this volume aims at supporting clinicians and scientists, interested in the innovative approach of cybertherapy.

Because of the complexity of this topic, we have put a great deal of effort into defining the structure of the book and the sequence of the contributions, so that those in search of a specific reading path will be rewarded. To this end we have divided the book into five main sections comprising 14 chapters overall:

1. *Cybertherapy rationale: advantages of new technologies for Clinical Psychology*
2. *Cybertherapy experiences: clinical trials in the treatment of mental disorders*
3. *Cybertherapy technology: advanced tools for Clinical Psychology*
4. *Cybertherapy ergonomics: how to design effective Cybertherapy tools*
5. *The future of Cybertherapy: new scenarios and applications*

Each section begins with a brief abstract, helping the readers in identifying the relationships among its chapters.

Section I - Cybertherapy rationale: advantages of new technologies for Clinical Psychology

In Chapter 1, **Riva and colleagues** present the VEPSY UPDATED Project, whose aim is to understand and to exploit the potential offered by an emerging field – *cybertherapy* – whose focus is the use of communication and information technologies to improve the health care processes. The chapter provides the clinical and technical rationale behind the cybertherapy applications, focusing on the advantages of the three different faces of virtual reality in the cybertherapy field: technological, experiential and communicative.

An integration of different Internet-based tools developed within the VEPSY UPDATED Project - the VEPSY website - is presented in Chapter 2, by **Castelnuovo and colleagues.** It is an example of clinical application, matching traditional practices with

innovative media for the treatment of different mental disorders. With the aim of giving a framework for the integration of old and new tools in mental health care, the rationale of the chapter consists on providing the possible scenarios for the use of the VEPSY website in the clinical process.

Botella and colleagues in Chapter 3 provide an historical review of Virtual Reality (VR) as therapeutic tool in clinical psychology. The authors present a comparison between the "traditional" VR-based treatments and the innovative ones. Moreover, data on the effectiveness of this technology application in the treatment of different psychological disorders, such as anxiety, eating and sexual disorders are presented with a particular attention to the actual limitations of VR and to the future perspectives.

Morganti in Chapter 4, starting from the analysis of existing VR-based applications, outlines the possibility of developing virtual reality tools for the assessment and treatment of neuropsychological diseases. The investigation on the possibilities and challenges related to the virtual-reality-based neuropsychological application is focused both on patient's and therapist's point of view. More in detail, an explanation of neuropsychological-oriented VR applications is discussed in order to highlight their usefulness and effectiveness in clinical treatments of memory, motor abilities, executive functions and spatial representation impairments.

Session II - Cybertherapy experiences: clinical trials in the treatment of mental disorders

Chapter 5 by **Botella and colleagues** shows one of the possible applications of virtual reality in the treatment of mental disorders: the treatment of Panic Disorder with Agoraphobia (PDA). Furthermore the chapter discusses how Virtual Reality treatments could help to achieve specific therapeutic goals. The clinical program developed for the treatment of PDA is described together with the efficacy and effectiveness of this particular treatment. The chapter presents the data of a study where a cognitive-behavioral program including VR for the exposure component is compared with a standard cognitive-behavioral program including *in vivo* exposure and with a waiting list control condition.

The chapter by **Klinger and colleagues** (Chapter 6), presents a VR-based clinical protocol to treat social phobia. The novelty of this work is to address a larger group of situations that the phobic patients experience with high anxiety. In the presented protocol, the efficacy of the virtual reality treatment is compared to the established and well validated group cognitive-behavioral treatment.

Riva and colleagues in Chapter 7 present a new Virtual Reality-enhanced treatment, named Experiential Cognitive Therapy (ECT), detailing its rationale and therapeutical protocols for the treatment of obesity and eating disorders. Moreover, the chapter presents the data from a clinical trial where the results of this treatment are compared with the mostly used approaches in the treatment of these disturbances (cognitive-behavioral therapy and the nutritional therapy).

Finally, the chapter by **Optale and colleagues** (Chapter 8) describes a therapeutic approach in which psycho-dynamic psychotherapy is integrated with Virtual Environments (VEs) to treat male sexual dysfunctions of presumably psychological or mixed origin. The presented data show that the particular way in which full-immersion VR involves the patient, is able to speed up the therapeutic psycho-dynamic process and produces better results than traditional treatments.

Section III - Cybertherapy technology: advanced tools for Clinical Psychology

Chapter 9 by **Rey and colleagues** presents new technologies that will provide

psychological treatment and help at any place and any time. Examples of this scenario are dynamic web pages, that include information prepared by the therapist for different patients and that receive information from them. These pages can be linked with other tools such as e-mail or chats, offering a direct patient-therapist communication. According to this view Virtual Environments can also be integrated in web pages to deliver advanced therapy support.

Alcañiz and colleagues in Chapter 10 focus on user interface design as a critical component of any Virtual Environment application, and especially for VEs applied to health care. The authors show how non-traditional devices and interface components are quickly proliferating and how three-dimensional, multisensory output technologies are also becoming more common. These considerations are supported by an overview of 3-D interaction and user interfaces technologies for VEs.

Section IV - Cybertherapy ergonomics: how to design effective Cybertherapy tools

In Chapter 11, **Spagnolli and colleagues** describe the usability evaluation of the Virtual Environment for the treatment of male sexual dysfunctions presented in Chapter 8. After the description of the conceptual framework adopted, the chapter dwell on one method among those deployed for the evaluation, namely the analysis of "situated actions". The main parameters used for the evaluation are the goals and the intended meanings of the simulation as set by the designers.

The identification of the usability requirements of specific community of practices is discussed in Chapter 12, by **Galimberti and colleagues.** Two of the four VR modules in the framework of the VEPSY project are considered: Panic Disorders – Agoraphobia and Eating Disorders, described in Chapter 5 and Chapter 7. The theoretical background used in this analysis is based upon an ethnomethodological approach, a perspective that gives evidence of how people, in specific social situations, are able to solve complex tasks producing shared meanings and achieving their goals during interaction.

Section V - The future of Cybertherapy: new scenarios and applications

In this section, which tries to outline the current state of research and technology that will be relevant to the development of innovative communication interfaces in health care, **Riva and colleagues** (Chapter 13) describe the Immersive Virtual Telepresence (IVT) technology. This innovative tool merges virtual reality environments with wireless multimedia facilities and advanced input devices, including biosensors and brain-computer interfaces. The authors discuss the clinical principles and possible advantages associated with the use of IVT in cybertherapy.

Chapter 14 by **Wiederhold B. and Wiederhold M.** deals with the novel applications of VR-Based technologies, highlighting both the advantages over traditional treatment modalities, and the problems experienced by the first clinical trials using these tools. Future directions for research are given, including improvements of objective measures of efficacy as fMRI and physiological monitoring devices. Finally, suggestions are provided to verify if VR and advanced technologies can be used in the treatment of many disorders, including depression, schizophrenia, drug addiction, and autism.

The wide array of perspectives described in the five Sections strengthens the importance of cybertherapy in health care. As this approach continues to develop, it will be compared more and more with existing methods. In order to achieve this goal, an interdisciplinary approach is essential. Moreover, the integration of knowledge coming from different disciplines, such as clinical, social and cognitive psychology, neuroscience,

ergonomics, multimedia development, or communication engineering, and the incorporation of the insights from these fields will lead to the development of a powerful clinical application in the future.

The Editors want to thank all the people and institutions that have supported this book and the work described in it. We have benefited from European Union support and in particular from Luciano Beolchi's and Diane Whitehouse's friendship. In particular Diane not only provided detailed comments on many issues faced by the VESPY Updated project, but also discussed the content and the status of this project with us over many months.

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In conclusion, we expect that the contents of this book will stimulate more clinicians and professionals in finding new solutions both to expand their intervention interests and in making better use of traditional and innovative cybertherapy tools.

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SECTION I

CYBERTHERAPY RATIONALE: ADVANTAGES OF NEW TECHNOLOGIES FOR CLINICAL PSYCHOLOGY

The possible role of virtual reality (VR) in clinical psychology derives prevalently from the central role occupied by the imagination and by memory in psychotherapy... VR produces a change with respect to the traditional relationship between client and therapist. The new configuration of this relationship is based on the awareness of being more skilled in the difficult operations of recovery of past experiences through the memory and of foreseeing future experiences through the imagination. At the same time, subjects undergoing treatment perceive the advantage of being able to recreate and use a real experiential world within the confines of their therapists' clinical offices.

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1 Cybertherapy in Practice: The VEPSY Updated project

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Abstract: Rapid and far-reaching technological advances are changing the ways in which people relate, communicate, and live. Technologies that were hardly used ten years ago, such as the Internet, e-mail, and video teleconferencing are becoming familiar methods for diagnosis, therapy, education and training. This is producing an emerging field – *cybertherapy* – whose focus is the use of communication and information technologies to improve the health care processes.
To exploit and understand this potential was the aim of the " Telemedicine and Portable Virtual Environment in Clinical Psychology" - VEPSY UPDATED – a European Community funded research project (IST-2000-25323, http://www.cybertherapy.info).
The chapter describes the clinical and technical rationale behind the cybertherapy applications developed by the project. Further, the actual role of virtual reality in the cybertherapy field is discussed, focusing on the advantages provided by its three different faces: technological, experiential and communicative.

1. Introduction

Since the development of methods of electronic communication clinicians have been using information and communication technologies in health care: telegraphy, telephony, radio and television have been used for distance medicine since mid 19th century [1]. However, rapid and far-reaching technological advances are changing the ways in which people relate, communicate, and live. Technologies that were hardly used ten years ago, such as the Internet, e-mail, and video teleconferencing are becoming familiar methods for diagnosis, therapy, education and training. This is producing an emerging field – *cybertherapy* – whose focus is the use of communication and information technologies to improve the health care processes.

To exploit and understand this potential is the overall goal of the " Telemedicine and Portable Virtual Environment in Clinical Psychology" - VEPSY UPDATED – a European Community funded research project (IST-2000-25323, http://www.cybertherapy.info) whose specific goal was the development of different PC based cybertherapy solutions to be used in clinical assessment and treatment of social phobia, panic disorders, male sexual disorders, obesity and eating disorders [2].

The paper describes the clinical and technical rationale behind the cybertherapy applications developed by the project. Specifically the paper focuses its analysis on the possible role of VR in clinical psychology and how it can be used for improving therapeutic change.

2. The role of Virtual Reality in Cybertherapy

Within the emerging cybertherapy field, a central role could be played by virtual reality (VR). In fact, the possible impact of virtual reality on health care is even higher than the one offered by the new communication technologies [3]. In fact, VR is a technology, a communication interface and an experience [4]. This is why the research in the virtual reality field is moving fast. If we check the two leading clinical databases – MEDLINE and PSYCINFO – using the "virtual reality" keyword we can find 1023 papers listed in MEDLINE and 730 in PSYCINFO (all fields query, accessed 9 December 2003).

From the analysis of the retrieved papers we can find that the first health care applications of VR started in the early '90s by the need of medical staff to visualize complex medical data, particularly during surgery and for surgery planning [5]. Actually, surgery-related applications of VR fall mainly into three classes: surgery training, surgery planning and augmented reality for surgery sessions in open surgery, endoscopy, and radiosurgery. A couple of years later, the scope of VR applications in medicine has broadened to include neuropsychological assessment and rehabilitation [6, 7]. In general, VR has two faces.

For physicians and surgeons, the ultimate goal of VR is the presentation of virtual objects to all of the human senses in a way identical to their natural counterpart [8]. As noted by Satava and Jones [9], as more and more of the medical technologies become information-based, it will be possible to represent a patient with higher fidelity to a point that the image may become a surrogate for the patient – the *medical avatar*. In this sense, an effective VR system should offer real-like body parts or avatars that interact with external devices such as surgical instruments as near as possible to their real models.

For clinical psychologists and rehabilitation specialists the ultimate goal is radically different [10-12]. They use VR to provide a new human-computer interaction paradigm in which users are no longer simply external observers of images on a computer screen but are active participants within a computer-generated three-dimensional virtual world. Within the VE the patient has the possibility of learning to manage a problematic situation related to his/her disturbance [13]. The key characteristics of virtual environments for these professionals are both the high level of control of the interaction with the tool without the constraints usually found in computer systems, and the enriched experience provided to the patient [14]. Virtual environments are highly flexible and programmable [15]. They enable the therapist to present a wide variety of controlled stimuli, such as a fearful situation, and to measure and monitor a wide variety of responses made by the user. This flexibility can be used to provide systematic restorative training that optimize the degree of transfer of training or generalization of learning to the person's real world environment [16].

In fact, VR offers a blend of attractive attributes for the psychologists and rehabilitators. The most basic of these is its ability to create a 3D simulation of reality that can be explored by patients. VR can be considered a special, sheltered setting where patients can start to explore and act without feeling threatened. In this sense the virtual experience is an "empowering environment" that therapy provides for patients [17]. As noted by Botella and colleagues [18] nothing the patients fear can "really" happen to them in VR. With such assurance, they can freely explore, experiment, feel, live, experience

feelings and/or thoughts. VR thus becomes a very useful intermediate step between the therapist and the real world.

Following this approach, we can try to define VR in terms of human experience [19] "a real or simulated environment in which a perceiver experiences telepresence," where telepresence can be described as the "experience of presence in an environment by means of a communication medium" (pp.78-80).

This position better clarifies the possible role of VR in cybertherapy: a communication interface based on interactive 3D visualization, able to collect and integrate different inputs and data sets in a single real-like experience.

This is possible because the key characteristic of VR, differentiating it from other media or communication systems, is the sense of *presence* [20, 21]. What is presence? Even if usually presence is defined as the "sense of being there" [19], or as the " feeling of being in a world that exists outside of the self" [22], it is now widely acknowledged that presence can be considered as a neuropsychological phenomenon [20, 23-28]. In particular, Riva and Waterworth described presence as a defining feature of self, related to the evolution of a key feature of any central nervous system [22]: the embedding of sensory-referred properties into an internal functional space. More in particular, without the emergence of the sense of presence it is impossible for the nervous system to separate between an external world and the internal one. If in simple organisms, this separation involved only a correct coupling between perceptions and movements, in humans it also requires the shift from meaning-as-comprehensibility to meaning-as-significance.

Meaning-as-comprehensibility refers to the extent to which the event fits with our view of the world (for example, as just, controllable, and nonrandom) whereas meaning-as-significance refers to the value or worth of the event for us [29]. Following this point, contributions to the intensity of the sense of presence come from three layers of the self recently defined by Damasio [30]: proto self, core self and autobiographical self. The more the three layers are integrated (focused on the same events) the stronger the intensity of the presence feeling [22]. This means that having two equally stimulating virtual environments, humans are more present in the one more relevant to their own goals.

3. VEPSY UPDATED: The cybertherapy rationale

VR is starting to play an important role as cybertherapy tool in clinical psychology [31, 32], that is expected to increase in the next years. According to a recent positioning paper on the future of psychotherapy [33], the use of VR and computerized therapies are ranked respectively 3rd and 5th out.

Up to now, the most common application of VR in clinical psychology is the treatment of phobias [34]. And the VEPSY Updated project, too, addressed phobias.

Particularly, the Spanish group headed by Cristina Botella focused on the treatment of panic disorder and agoraphobia. On the other side, the French clinical group headed by Patrick Legeron addressed the treatment of social phobia.

The overall rationale shared by the two groups is very simple: in VR the patient is intentionally confronted with the feared stimuli while allowing the anxiety to attenuate.

Because avoiding a dreaded situation reinforces all phobias, each exposure to it actually lessens the anxiety through the processes of habituation and extinction.

The use of VR exposure (VRE) offers a number of advantages over in vivo or imaginal exposure: can be administered in traditional therapeutic settings ad it is more controlled, and cost-effective than in vivo exposure. Another advantage of VR is the possibility of carrying out exposure to bodily sensations (interoceptive) and situational exposure simultaneously. Traditionally, exposure for panic disorder involves exposure to

agoraphobic situations and interoceptive exposure that are performed in different sessions. VR allows the exposure of the patient to an agoraphobic situation (i.e. a train), and simultaneously, can elicit bodily sensations through visual or sound effects (blurry vision, pounding heart, etc). In different controlled studies VRE was as effective as in vivo therapy in the treatment of acrophobia [35, 36], spider phobia [37] and fear of flying [38-41].

The second part of the project focuses on obesity and eating disorders. Particularly, Riva and his clinical group lead by Bacchetta and Molinari [42, 43], are using the Experiential Cognitive Therapy (ECT) an integrated approach ranging from cognitive-behavioral therapy to virtual reality sessions in the treatment of eating disorders and obesity. In this approach VR is mainly used to modify body image perceptions.

What is the rationale behind this approach? Different studies show that body image dissatisfaction can be considered a form of *cognitive bias* [44, 45]. The essence of this cognitive perspective is that the central psychopathological concerns of an individual bias the manner in which information is processed. Usually, this biased information processing occurs automatically. Also, it is generally presumed that the process occurs almost outside the person's awareness unless the person consciously reflects upon his or her thought processes (as in cognitive therapy).

According to Williamson and colleagues [44] body size overestimation can be considered as a complex judgment bias, strictly linked to attentional and memory biases for body related information: "If information related to body is selectively processed and recalled more easily, it is apparent how the self-schema becomes so highly associated with body-related information... If the memories related to body are also associated with negative emotion, activation of negative emotion should sensitize the person to body-related stimuli causing even greater body size overestimation" (pp.49-50).

It is very difficult to counter a cognitive bias. In fact, biased information processing occurs automatically and the subjects are unaware about it. So, for them, the biased information is real. They cannot distinguish between perceptions and biased cognitions.

Moreover, any attempt for convincing them is usually useless and sometimes produce a strong emotional defense. In fact, the denial of the disorder and resistance to treatment are two of the most vexing clinical problems in these pathologies [46, 47].

Given these difficulties there are only two different approaches to the treatment of body image disturbances [45]:

- *cognitive-behavioral strategies*: This approach is based on assessment, education, exposure and modification of body image. The therapy both identifies and challenges appearance assumptions, and modifies self-defeating body image behaviors [48-50].
- *feminist approach*: Feminist's therapists usually use experiential techniques, such as guided imagery, movement exercises, and art and dance therapy [51, 52]. Other experiential techniques include free-associative writing regarding a problematic body part, stage performance, or psychodrama [52, 53].

Unfortunately both approaches, even if effective in the long term, requires a strong involvement of the patient and many months of treatment.

The use of VR offers two key advantages. On one side, it is possible to integrate all different methods (cognitive, behavioral and experiential) commonly used in the treatment of body experience disturbances within a single virtual experience. On the other side, VR can be used to induce in the patient a controlled sensory rearrangement that unconsciously modifies his/her bodily awareness (body schema). When we use a virtual reality system we feel our self-image projected onto the image of the visual cues (i.e. a certain figure or an abstract point, such as cursors, which moves in accordance with the movement of our own hand) appearing in the video monitor, as a part of or an extension of our own hands [54].

As noted by Iriki and colleagues [55] "Essential elements of such an image of our

own body should be comprised of neural representations about the dimension, posture and movement of the corresponding body parts in relation to the environmental space. Thus, its production requires integration of somatosensory (intrinsic) and visual (extrinsic) information of our own body in space." (p. 163). When this happens the information itself becomes accessible at a conscious level [56] and can be modified more easily.

In a case study a 22-year old female university student diagnosed with Anorexia Nervosa was submitted to the ECT treatment [57]. At the end of the in-patient treatment, the subject increased her bodily awareness joined to a reduction in her level of body dissatisfaction. Moreover, the patient presented a high degree of motivation to change.

Expanding these results, they carried different clinical trials on female patients [58-62]: 25 patients suffering from binge-eating disorders were in the first study, 20 in the second, and 18 obese in the third. At the end of the inpatient treatments, the patients of both samples modified significantly their bodily awareness. This modification was associated to a reduction in problematic eating and social behaviors.

The third clinical focus of the VEPSY Updated project was the treatment of male sexual disturbances. In particular, Optale and his team [63, 64] used immersive virtual reality to improve the efficacy of a psychodynamic approach in treating male erectile disorders.

In the proposed VE four different expandable pathways open up through a forest, bringing the patients back into their childhood, adolescence and teens when they started to get interested in the opposite sex. Different situations are presented with obstacles that the patient had to overcome to go on. VR environments are here used as a form of controlled "dreams" allowing the patient to express in a nonverbal way transference reactions and free associations related to the ontogenetic development of male sexual identity. General principles of psychological dynamisms such as the difficulty with separations and ambivalent attachments are used to inform interpretive efforts.

The obtained results - 30 out of 36 patients with psychological erectile dysfunction and 28 out of 37 patients with premature ejaculation maintained partial or complete positive response after 6-month follow up - show that VR seems to hasten the healing process and reduce dropouts. Moreover, Optale used *PET* scans to analyze regional brain metabolism changes from baseline to follow-up in patients treated with VR [65]. The analysis of the scans showed different metabolic changes in specific areas of the brain connected with the erection mechanism, suggesting that this method accelerated the healing process by reopening old brain pathways or consolidating them. The results also suggest that new mnemonic associations and rarely-used inter-synaptic connections, characterized by a particular magnitude of activation may be established, favoring satisfaction of natural drives [64].

4. VEPSY Updated: The technical rationale

To produce the cybertherapy applications used in its clinical application the VEPSY Updated project used PC based VR platforms. The following paragraphs both describe the rationale behind this choice and detail the technical characteristics of the VR platform chosen by the project.

4.1 PC based cybertherapy

Even if the history of VR is based on expensive graphic workstations, the significant advances in PC hardware that have been made over the last three years, are allowing the appearance of low cost VR systems. While the cost of a basic desktop VR system has not

changed much, the functionality has improved dramatically, both in terms of graphics processing power and VR hardware such as head-mounted displays (HMDs). The availability of powerful PC engines based on Intel's Pentium IV, AMD's Athlon and Motorola's Power PC G4, and the emergence of reasonably priced 3D accelerator cards allow high-end PCs to process and display 3D simulations in real time.

A standard Celeron/Duron 2 Ghz system with as little as 128 Mb of RAM can offer sufficient processing power for a bare-bone VR simulation, a 2.6 Ghz Pentium III//Athlon with 256 Mb of RAM, can provide a convincing virtual environment, while a dual 3.2 Ghz Pentium IV XEON configuration with OpenGL acceleration, 512 Mb of RAM and 128/256 Mb of VRAM running on Windows XP Professional, can match the horsepower of a graphics workstation [4].

Immersion is also becoming more affordable. For example, it is possible to have a basic HMD with gyroscopic head tracking for less than $1200 and has built in. For instance, Olympus (Japan) distributes its basic video headset for about $600 without head tracking. Two years ago HMDs of the same quality were about 10 times more costly. A HMD with VGA quality and 3D video produced by a Korean manufacturer is now about $2,500. However, this price will probably decrease during the next five years.

Presently, input devices for desktop VR are largely mouse- and joystick-based.

Although these devices are not suitable for all applications, they can keep costs down and avoid the ergonomic issues of some of the up-to-date I/O devices such as 3D mouses and gloves. Also, software has been greatly improved over the last three years. It now allows users to create or import 3D objects, to apply behavioral attributes such as weight and gravity to the objects, and to program the objects to respond to the user via visual and/or audio events.

4.2 VESPY UPDATED: The Software

Each module was created by using the software Virtools Dev. 2.0 (http://www.virtools.com). Based on a building-block, object-oriented paradigm, Virtools makes interactive environments and characters by importing geometry and animation from several animation packages, including Discreet 3D Studio MAX (http://www.discreet.com), Alias Wavefront Maya (http://www.aliaswavefront.com), Softimage (http://www.softimage.com), and Nichimen Nendo and Mirai (http://www.nichimen.com), and combining them with an array of more than 200 basic behaviors. By dragging and dropping the behavior blocks together the user can combine them to create complex interactive behaviors.

The Virtools toolset consists of Virtools Creation, the production package that constructs interactive content using behavior blocks; Virtools Player, the freely distributable viewer that allows anyone to see the 3D content; Virtools Web Player, a plug-in version of the regular player for Netscape Navigator and Microsoft Internet Explorer; and the Virtools Dev for developers who create custom behaviors or combine Virtools with outside technology. Virtools Dev includes a full-blown software development kit (Virtools SDK) for the C++ developer that comes with code samples and an ActiveX player which can be used to play Virtools content in applications developed with tools such as Frontpage, Visual Basic or Visual C++.

Content created with Virtools can be targeted at the stand-alone Virtools Player, at web pages through the Virtools Web Player, at Macromedia Director, or at any product that supports ActiveX. Alternatively, the Virtools SDK allows the user to turn content into stand-alone executable files. Virtools's rendering engine supports DirectX, OpenGL, Glide and software rendering, although hardware acceleration is recommended.

4.3 VESPY UPDATED: The Hardware

All the VR-based clinical modules were developed around on the following PC platforms:

- *Pentium IV/Athlon XP desktop VR system:*
  - 2600 mhz or better,
  - 256 mega RAM or better,
  - minimum specification for the graphic engine: ATI Radeon 9600 XT 64MB VRam or Nvidia GeForce FX 5600 Ultra 64Mb VRam
- *Pentium IV/Athlon based portable VR system:*
  - 2600 mhz or better,
  - 256 mega RAM or better,
  - minimum specification for the graphic engine: ATI Radeon 9600 mobile 64Mb VRam or Nvidia GeForce FX Go 5600 64Mb VRam

The hardware also includes:

- *a head mounted display (HMD) subsystem.* The HMDs used are:
  - Glasstron PLM-A35/PLM-S700 from Sony Inc (http://www.sel.sony.com/SEL/). The Glasstron uses LCD technology (two 0.7" active matrix color LCD's) displaying 180000 pixels (PLM-A35: 800H x 225V) or 520000 pixels (PLM-S700: 832H x 624V) to each eye. Sony has designed its Glasstron so that no optical adjustment at all is needed, aside from tightening a two ratchet knobs to adjust for the size of the wearer's head. There's enough "eye relief" (distance from the eye to the nearest lens) that it's possible to wear glasses under the HMD. The motion tracking is provided by Intersense through its InterTrax 30 serial gyroscopic tracker (Azimuth: ±180 degrees; Elevation: ±80 degrees, Refresh rate: 256Hz, Latency time: 38ms ± 2).
  - VFX-3D from Interactive Imaging Systems Inc (http://www.iisvr.com). The VFX-3D uses LCD technology (two 0.7" active matrix color LCD's) displaying 360000 pixels (800H x 400V) to each eye. The HMD doesn't require any optical adjustment. It can be easily worn using the patented flip-up visor. Included is also an accelerometer based serial tracker (Pitch & Roll Sensitivity +/- 70 degrees +/- ~0.1 degrees; Yaw Sensitivity 360 degrees +/-0.1 degrees)
- *a two-button joystick-type input device* to provide an easy way of motion: pressing the upper button the operator moves forward, pressing the lower button the operator moves backwards. The direction of the movement is given by the rotation of operator's head.

To ensure the broadest user base, al the VR modules have been developed as shared telemedicine tool available through Internet (see paragraph below) by using a plug-in for the most common browsers (Explorer and Navigator) and as portable tools based on Speed-Step notebook PCs (Pentium IV/Duron, 16MB VRam and 256 Mb Ram). This choice ensures wide availability, an open architecture and the possibility of benefiting from the improvements planned for these machines by INTEL and AMD, mainly faster processors and enhanced multimedia support. Both solutions allow the support of end-users in their living environment.

5. Conclusions

VR can be considered a sophisticated cybertherapy tool that supports the communication process between patient and therapists [69]. Even if the three applications developed by the VEPSY Updated project have a very different rationale, all use VR as a communication

interface, able to collect and integrate different inputs and data sets in a single real-like experience. Using it accordingly, is possible to target a specific cognitive or emotional system without any significant change in the therapeutic approach. For instance, behavioral therapists may use a VE for activating the fear structure in a phobic patient through confrontation with the feared stimuli; a cognitive therapist may use VR situations to assess situational memories or disrupt habitual patterns of selective attention; experiential therapists may use VR to isolate the patient from the external world and help him/her in practicing the right actions; psychodynamic therapists may use VEs as complex symbolic systems for evoking and releasing affect.

In general VR can be an important support tool to the change process. Change in therapy usually comes through an intense focus on a particular instance or experience [66].

Within this general model we have the insight-based approach of psychoanalysis, the schema-reorganization goals of cognitive therapy, the functional analysis of behavioral activation, the interpersonal relationship focus of the interpersonal therapy, or the enhancement of experience awareness in experiential therapies.

What are the differences between them? According to Safran and Greenberg [67], behind the specific therapeutic approach we can find two different models of change: bottom-up and top-down. Bottom-up processing begins with a specific emotional experience and leads eventually, to change at the behavioral and conceptual level, whereas top-down change usually involves exploring and challenging tacit rules and beliefs that guide the processing of emotional experience and the behavioral planning. These two models of change are focused on two different cognitive systems, one for information transmission (top-down) and one for conscious experience (bottom-up), both of which may process sensory input [68]. The existence of two different cognitive systems is clearly showed by the dissociation between verbal knowledge and task performance: people learn to control dynamic systems without being able to specify the relations within the system, and they can sometimes describe the rules by which the system operates without being able to put them into practice.

Even if many therapeutic approaches are based on just one of the two change models, a therapist usually requires both [66]. Some patients seem to operate primarily by top-down information processing, which may then prime the way for corrective emotional experiences. For others the appropriate access point is the intensification of their emotional experience and their awareness of both it and related behaviors. Finally, different patients who initially engage the therapeutic work only through top-down processing, may able later in the therapy to make use of bottom-up emotional processing. In this situation, a critical advantage can be provided by VR.

In fact, one of the main results of the VEPSY Updated project was the use of VR as an *advanced imaginal system*: an experiential form of imagery located between imagination and reality [31, 32, 70] that can be used to help the patient in differentiate between perception and cognition. As noted by Glantz and colleagues [71]: "one reason it is so difficult to get people to update their assumptions is that change often requires a prior step - recognizing the distinction between an assumption and a perception. Until revealed to be fallacious, assumptions constitute the world; they seem like perceptions, and as long as they do, they are resistant to change." (p. 96). Using the sense of presence induced by VR, the therapist can actually demonstrate to the patient that what looks like a perception doesn't really exist. Once this has been understood, individual maladaptive assumptions can then be challenged more easily.

However, significant efforts are still required to move cybertherapy into routine clinical use. Clearly building new and additional virtual environments - possibly networked and integrated in portable devices such as PDAs or cellular phones - is important so therapists will continue to investigate applying these tools in their day-to-day

clinical practice [6]. In fact, in most circumstances, the clinical skills of the therapist remain the key factor in the successful use of cybertherapy systems.

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2 New tools in cybertherapy: the VEPSY Web Site

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Abstract In the last years the rapid development of the Internet and new communication technologies has had a great impact on psychology and psychotherapy. Psychotherapists seem to rely with more and more interest on the new technological tools such as videophone, audio and video chat, e-mail, SMS and the new Instant Messaging Tools (IMs). All these technologies outline a stimulating as well as complex scenario: in order to effectively exploit their potential, it is important to study which is the possible role played by the Internet-based tools inside a psychotherapeutic iter. Could the technology substitute the health care practitioners or are these tools only a resource in addition to the traditional ones in the therapist's hand? The major aim of this chapter is to provide a framework for the integration of old and new tools in mental health care. Different theoretical positions about the possible role played by e-therapy are reported showing the possible changes that psychotherapy will necessarily face in a cyber setting. The VEPSY website, an integration of different Internet-based tools developed within the VEPSY UPDATED Project, is described as an example of clinical application matching between old (and functional) practices with new (and promising) media for the treatment of different mental disorders. A rationale about the possible scenarios for the use of the VEPSY website in the clinical process is provided.

1. Introduction

In the last years the rapid development of Internet and new communication technologies is having a growing impact on psychology and psychotherapy. The widespread presence of "user friendly" computers allows more and more people and professionals (psychologists, psychotherapists, etc.) to use the Internet and other technological tools in the field of psychology.

A recent survey on a sample of 1000 psychologists selected from APA has shown that only 2% of respondents (596 practitioners with the median age of 50, ranging from 33 to 72) had used Internet-based technologies in the delivery of health care [1]. Even if

nowadays the integration between "techno" and "psycho" is still far, more and more psychologists are using an will use these technologies into their practice and research [2].

Stamm [3] observes that "psychologists do not have to become technology specialists to be competent providers of telehealth services... However, to best know when and how to use technology to support healing... psychologists will need more technology proficiency, particularly with computers, than has been the norm. This is particularly true for those who will be establishing their practices in the coming decades." (pp. 536-537).

To help psychologists and other professionals to learn new competencies for expanding their practice in telehealth field, self assessment questionnaires, guidelines and training programs are nowadays available [4].

According to Barak, there are at least ten types of psychological Internet applications in the field of health care, as indicated in the Table 1 [5].

Table 1. Types of psychological services provided on the Internet (from Barak [5])

1.	Information Resources on Psychological Concepts and Issues
2.	Self-Help Guides
3.	Psychological Testing and Assessment
4.	Help in Deciding to Go into Therapy
5.	Information about Specific Psychological Services
6.	Single-Session Psychological Advice Through E-Mail or E-Bulletin Board
7.	Ongoing Personal Counseling and Therapy Through E-Mail
8.	Real-Time Counseling Through Chat, Web Telephony, and Videoconferencing
9.	Synchronous and Asynchronous Support Groups, Discussion Groups, and Group Counseling
10.	Psychological and Social Research

Psychotherapists seem to rely not only on the traditional telephone [6], but also on the new technological tools such as videophone, audio and video chat, e-mail [2], SMS [7] and the new Instant Messaging Tools (IMs)[8]. In fact in 2001 the demand for health information online has been carried on by 100 millions of individuals in the United States [9].

In these changing clinical settings new terms have been coined to identify this fruitful integration between "technology" and "psychology-medicine": *telehealth* is the use of telecommunications and information technologies to provide access to health information, assessment, diagnosis, intervention, consultation, supervision, education and follow-up programs across geographical distance [10-13].

To stress the real added value and advantage of using Internet-based tools in clinical psychology, according to Glueckauf et al. [10], we report here four main reasons.

1. The possibility to provide health information and services across geographical distance for underserved population.

Internet can be the only possibility to allow the provision of appropriate health assistance in remote areas where specialized staff and facilities are not widespread: the AKAMAI Telemedicine Program, in the case of Hawai, and Alaska Telemedicine Program, in the case of Alaska, are two examples [3]. Glueckauf et al. [10] notes that "a wide array of telehealth services is currently offered across diverse settings, including hospitals, community mental health centers, long-term care facilities, schools, prisons, and rural health centers" (p. 160).

2. The possibility to increase the quality of health information and services in particular areas or for specific populations.

Ensuring health-services "on-line" could also reduce gaps of quality in treatments between different demographic groups [14], traditionally without the same possibility to reach Health-care organizations: there are considerable differences in the access to psychological services in the world. But opponents of e-therapy, as noted by Manhal-Baugus [15] state that "it is limited to clients who are reasonably educated writers and readers" and "this leads to the issue of elitism. The use of literally techniques to conduct therapy may be relegated to a select group of educated, middle to upper class individuals"; however "real-life psychotherapy is usually based on average intellectual abilities and skills and more costly than online therapies" (p. 559).

3. The possibility to ensure a continuous medical and psychological service overall for chronic disabilities reducing the cost of an extended traditional assistance.
The real cost effectiveness of telehealth programs has only little evidences but it is very likely for extended treatments where an Internet-based interaction between a therapist and a patient could avoid a physical contact saving economical, social and individual costs. Some examples could be followed up therapeutic sessions or brief consultations about the state of progress of psychotherapies in advanced steps.

4. The growing trend of patients' preference towards accessing therapy via a home-based computer system.
The status of "being on-line" is coming "normal" and more and more individuals are carrying on daily life activities in the Web including the search of on-line psychological treatments.

Another key advantage of using Internet-based tools in mental health field is related to the improvement and facility of the communication between different practitioners who take charge of the same patient. Until now the telephone has played a central role in the process of negotiating how activities involved in the treatment of patients can be scheduled, but new Internet-based tools are more and more used in the collaboration between different members of the clinical staff. These tools could support communication, problem solving and clinical decision-making process providing therapists with the possibility to share different records, information and clinical materials.

So new Internet-based tools could improve the relationship between patients and therapists and between practitioners who are taking charge of the same patient. About the first issue, "extensions of teletherapy to people in restricted conditions such as prisons, hospices, nursing homes need to be studied" [16].

2. The role of technology in psychotherapy

Inside this new technological scenario, in order to effectively exploit its potential, it is important to study which is the possible role played by the Internet-based tools inside a psychotherapeutic iter. Could the technology substitute the health care practitioners or are the tools only a resource in addition to the traditional ones in the therapist's hand?

According to Jerome and Zailor [17], something in the clinical field will be altered in the presence of emerging technologies, so "it is thus important to study the impact of these changes as they occur, and it is imperative that new technological competencies be developed as clinicians integrate these technologies into their research and practice" (p. 478).

So the coming of *e-therapy,* defined by Grohol [18] as "a new modality of helping people resolve life and relationship issues", opens a lot of questions about the status of "technology in psychotherapy". First of all, could psychotherapy be carried on using only technological tools without the traditional face-to-face interactions?

About this issue there are different theoretical positions that it is possible to summarize in five main ones:

1) *Psychotherapy could be made on-line and e-therapy differs from traditional treatments simply for the use of a technological medium.* According to this point of view, the methods, techniques and procedures related to a particular theory, model or approach used in psychotherapy are preserved and the only relevant difference is the change of setting from a f-2-f setting to an Internet-mediated one. Day and Shneider in a recent report examined the level of working alliance in three conditions (face-to-face, audio and video individual therapy) and noted that "the similarities among the three treatment groups – face-to-face, video teleconference and audio conference – came through more strongly than any differences" (p. 501)[16].

2) *Psychotherapy could be made on-line but e-therapy differs from the traditional treatments because the communication suffers from critical changes.* According to this position, communication by e-mail appears to completely lack the nonverbal cues and channel many of practitioners consider as an integral part of traditional approaches [19]. So some therapeutic scenarios, such as highly experiential setting and approaches that give great importance to the front-end diagnosis step, are strictly related to face-to-face situations and need to be deeply redesigned in case of using an Internet-based medium [19]. For some theorists the communication over the Internet would be an inadequate replacement for face-to-face intimacy [20].

3) *Psychotherapy could be made on-line and e-therapy could be preferentially used with some patients.* The absence of the nonverbal channel in cybertherapy has been traditionally perceived as a limit by practitioners but the difference between a f-2-f communication and an Internet-based one could be favorable for the technological scenario. Posture, tone, inflection, eye contact and other nonverbal cues can give the therapist a lot of precious information but can also overload, distract, confuse or intimidate the patient. E-mail contacts seem to be the way clients prefer to seek in spite of therapists' disapproval. Due to its "disinhibition effect" in comparison with face-to-face [21], cybertherapy could be an important choice for the treatment of anxiety disorders, at least in a first part of the therapy, during the creation of a functional working alliance. According to Day and Schneider [16], patients in e-therapy make "more of an effort to communicate, taking more responsibility for the interaction than they did in face-to-face traditional therapy" (p. 502) [16] or they could feel safer opening and telling more in a cyber situation in comparison with a traditional face-to-face setting. We have also to take into account that several psychological disorders result in extreme discomfort with human contact. "Agoraphobics, socially anxious and avoidant personalities often find close proximity with unfamiliar others intolerable. One possible tactic involves using telephone, video, and face-to-face communication with the psychotherapist as such a client gains trust and comfort" (p.502)[16]. Also Alleman noted that "although more research is needed, it seems plausible that people could communicate effectively online even when the content of their

communication is fraught with affective intensity" (p.503)[19]. According to this approach, Cohen and Kerr [22] found no significant differences in the effectiveness of the treatment between computer-mediated and face-to-face conditions with a sample of patients suffering from excessive anxiety [22].

4) *Psychotherapy is something different from e-therapy and web counseling.* Many authors differentiate the structured traditional clinical iter from a cyber therapeutic relationship [18, 23, 24]. Online it is possible to provide assessment, counseling and advices to choose and start a treatment but the Internet-based communication does not allow a traditional individual, group or family psychotherapy. Grohol discusses that "it would be inappropriate to compare it *(e-therapy)* to traditional face-to-face psychotherapy, assessment or traditional services" (p. 1)[18].

5) *E-therapy could only enhance traditional psychotherapy in some steps of it.* For this point of view, cybertherapy is only a preliminary (assessment) of final (follow-up) step of the therapeutic iter, but the most important methods, techniques and procedures related to a particular theory, model or approach could be carried on only in a traditional f-2-f setting. So e-therapy could be only a popular and widespread medium to lead people to traditional and functional psychotherapy.

In our view, an emerging scenario could characterize the future clinical setting: o*ld (and functional) practices could be integrated and enhanced through new (and promising) media.* This framework aiming at matching "techno" and "psycho" for clinical purposes will be explained in the next paragraph.

3. A framework for the integration of old and new tools in mental health care

The most critical issue in this converging space between technology and psychology is to which extent the innovative hypermedia tools could influence, block, exceed or support the old and functional techniques and protocols in psychotherapy. Is an integration possible?

In our view the basic principles, methods, techniques and procedures in the clinical fields have not to be changed: *e-therapy* should not modify theories, techniques and methods typical of each approach (psychoanalytic, systemic, cognitive, behavioral, interpersonal, strategic, etc.) but could affect the level of communication and so the possible relationship and alliance between the therapist and the patient (see the Table 2).

The traditional setting could move into a cyber (or virtual, synthetic, etc.) world, without affecting the basic principles and methods of the therapeutic iter.

The next paragraph will shed light on an emerging kind of Internet-based tools: the *instant messaging* (IM) tools. For the traditional tools (e-mail, chat, videoconference, etc.) please go to the Alcaniz's chapter in this book for the technical features and to [8] for the psychological ones.

4. Emerging tools for e-therapy: how to use *instant messaging* (IM) in cybertherapy

According to the need of learning more about these new tools, this paragraph is dedicated to explain how to use *instant messaging* (IM), new emerging tools now available, in e-therapy. For a technical description of *instant messaging* (IM) tools please go to Table 3 [8].

Table 2. The possible role and influence of Internet-based tools on the levels of interaction between therapists and patients

	LEVELS OF INTERACTION BETWEEN THERAPIST AND PATIENT		
	Methods, techniques and procedures related to a particular theory, model or approach used in psychotherapy	**Communication**	**Relationship**
EXAMPLES FOR EACH LEVEL	In a cognitive approach some techniques are for example alternative interpretation, label shifting, cognitive reframing, etc.	The communication could be direct, indirect, evocative, hypnotic, more verbal or not-verbal oriented, etc...	Between a therapist and a patient there are different kinds of relationship according to the step of the therapy, the therapist's ability, the patient's resistance, etc.: so the possibilities among therapists and patients range between a lack of trust to an extreme confidence ("rapport") with a high level of therapeutic alliance.
DEGREE OF INFLUENCE OF INTERNET-BASED TOOLS ON EACH LEVEL	**LOW**	**HIGH**	**HIGH**
CONSIDERATIONS	The methods/techniques are dependent on theory/approach and not on the *medium* used. So a particular technique could be used in a face to face interaction as effectively as using a simple Internet-based tool.	The communication could be limited or enhanced according to the *medium* used. If an Internet-based tool, such as written chat, does not allow the use of not verbal language, the communication could be deeply compromised.	The communication is one of the key factors in the creation of a good relationship and alliance between a therapist and a patient. So a limited communication could drive to a dysfunctional relationship.
GENERAL INDICATIONS FOR A FRUITFUL USE OF INTERNET-BASED TOOLS IN PSYCHOTHERAPY	At this level the main suggestion is to use Internet-based tools that at least could ensure the basic rules of communication in order to allow patients to understand the indications provided by therapists.	It is necessary to allow a complete communication (verbal and not verbal), as much as possible, between therapist and patient. New Instant Messaging Tools *(see par.3)* are advised because they could ensure a wide communication due to their integration of different *media* and *languages*.	Internet-based tools could be introduced only after the creation of a "good-enough" relationship between therapist and patient that is typical of the first step of the treatment in a traditional setting. Moreover, during the others steps of the therapeutic iter, a verbal and not-verbal communication has to be ensured in order not to loose the previously built relationship. So new Instant Messaging Tools *(see par.3)* are advised.

These tools can be described as "on-line setting where networks of multimedia nodes connected by links are used to present information and manage retrieval" (p. 662)[25].

While a hypertext consists primarily of textual information, hypermedia includes multiple information formats, such as visual, musical and animation elements. When hypermedia are used as communication tools, they are defined *instant messaging* (IM) tools [26].

Table 3. Synoptic chart of software features, system's requirements and usability (updated from Castelnuovo [8])

Software	Features	Usability	System's requirements
NetMeeting	• Video/audio conferencing; • Files/programs sharing; • Desktop sharing; • Whiteboard; • Text chat.	User interface: easy Learning rate: fast	Win 95, Win 98 or Win Me, Pentium II processor with 128 MB of RAM (recommended). 10 MB of free hard disk space, ISDN or LAN connection. Sound card with microphone and speakers. Video capture card or camera that provides a Video for Windows capture driver (required for video support).
Paltalk	• Video/audio conferencing; • Voice mail; • Text chat; • Voice chat.	User interface: easy Learning rate: fast	Win 95/98/NT4/2000/XP, Pentium 120 MHz, 64 MB RAM (recommended 128 MB), Internet Explorer 4.0, ISDN or LAN connection. Sound card with microphone and speakers, USB video camera.
Eyeball chat	• Video/audio conferencing; • Group video conferencing; • Video mail; • Text chat.	User interface: easy Learning rate: fast	Win 98, ME, 2000 or XP; Microsoft DirectX 7.0, Pentium 166 MHz, at least 64 MB RAM (128 MB recommended), Internet Explorer 4.0, ISDN or LAN connection. Sound card with microphone and speakers, USB video camera.
AOL Instant Messenger	• E-mail; • Text chat; • Voice chat; • Telephone over IP.	User interface: easy Learning rate: fast	Internet Explorer 4.5, Internet connection, Pentium I processor or higher, 16 MB RAM, 5 MB Hard Disk, sound card with microphone and speakers, Windows 95, 98, NT or XP, Microsoft Virtual Machine.
ICQ	• File sharing; • E-mail; • Text chat; • Contacts list sharing; • Voice chat; • Telephone over IP; • SMS.	User interface: complex Learning rate: slow	Internet Explorer 4.5, Internet connection, Pentium I processor or higher, 8 MB RAM, sound card with microphone and speakers, Windows 95, 98, NT or XP.
MSN Messenger	• File sharing; • Telephone over IP; • Voice chat; • SMS.	User interface: easy Learning rate: fast	Internet connection, Microsoft Internet Explorer 4.0, Netscape Navigator 4.0, Pentium I processor or higher, full-duplex sound card with microphone and speakers, 8 MB RAM, 2 MB Hard Disk, Windows 95, 98, Me, 2000, NT 4.0 or XP
Odigo	• File sharing; • Text chat; • Contacts list sharing; • Voice chat; • Web co-surf; • SMS.	User interface: easy Learning rate: slow	Internet connection, Pentium I processor or higher, full-duplex sound card with microphone and speakers, Windows 95, 98, Me, 2000, NT, XP.
Yahoo Messenger	• Voice mail; • Text chat; • Organizer; • File sharing.	User interface: easy Learning rate: fast	Internet connection, Pentium I processor or higher, full-duplex sound card with microphone and speakers, Windows 95, 98, Me, 2000, NT, XP.

The real added value of IMs, in comparison with traditional Internet-based tools such as chat, e-mail, videoconference, etc., is that this *medium* further enhances the user's experience by the integration of different forms of computer-mediated-communication (e-mail, IRC etc.) into one fully integrated interface. IMs could integrate the communication potential offered by the Internet with the richness of different multimedia contents.

About the practical possibilities provided to patients and therapists, IMs could go further than the traditional Internet-based tools because IMs could create a new setting (a psychotherapist's virtual office) where the whiteboard could allow to communicate (using verbal and not-verbal languages), to exchange and share information (video files, document, etc.) with an open channel between clients and care givers.

As indicated in Figure 1, in a hypothetical continuum between complete absence and presence of communication in the interaction between a therapist and a patient, IMs could more and more move closer to "face to face" situations that still remain the ideal situation for psychotherapy. E-mail, chat, VTC seem to affect the communication between two users but cannot recreate the clinical setting across distance.

Different users, who are simultaneously browsing the same website, can communicate with each other sharing different kinds of files. Usually, an IM allows the user to conduct group and private chats, to exchange information and files, and browse the same web-pages. On any website, IM users can see a list of other users and talk with them on group and private levels. Furthermore, each user can obtain a constantly updated list of all the other online users who are visiting the same website [26].

The table 3 provides a detailed description of the main features of most common IMs.

Taken together, the results of this review suggest that instant messaging are well-suited for a telemedicine application in psychotherapy [27]. However, the real effectiveness of such tools depends largely on the ability of therapists to coherently integrate the features of IMs in the clinical procedure.

For this reason, it would be useful to provide the reader with some insights regarding potential ways of using IMs in psychotherapy. The following considerations are not meant to be exhaustive, rather to stimulate the creativity and the curiosity of mental health professionals who are particularly interested in promoting new solutions for using Internet related technologies in the clinical practice.

By using IMs, the therapist and the patient are able to share pictures, screenshots and videos captured by a video camera installed on their workstations and to communicate their ideas and impressions using both the text chat and voice chat features. The "application sharing" feature enables the therapist to send to the patient a psychometric questionnaire for assessment purposes and receive the result in real time.

Consequently, the therapist is able to provide the patient with a feedback in a fraction of the time that this process normally requires. So therapists can carry on parts of the clinical process, e.g., diagnosis, therapeutic sessions, follow up, etc, using these new tools with patients.

The "virtual whiteboard" is another interesting feature that has promising applications. For example, the therapist can use the whiteboard to enrich his/her explanations with diagrams and drafts, which can be exported to other applications.

Finally, the text-chat feature allows the therapist to save the content of the dialogue as text file, making it available for future reference.

Less complex IMs represent an acceptable compromise between simplicity of use and richness of communication features. Although few exceptions, IMs have a very intuitive and easy-to-learn interface. This last feature is very important, because it makes IMs well suited also for novice Internet users. Another advantage of most IMs is that therapist can send the patient a request for a communication session using either the IM feature, if the patient is logged in, or e-mail. Once the session is open, the therapist can chat with the patient privately or in group, by sending a request to the other patients that are online at that moment. In some IMs, the users can rapidly move from the text chat to the voice chat, which has often a valuable quality. Furthermore, even using simple IMs

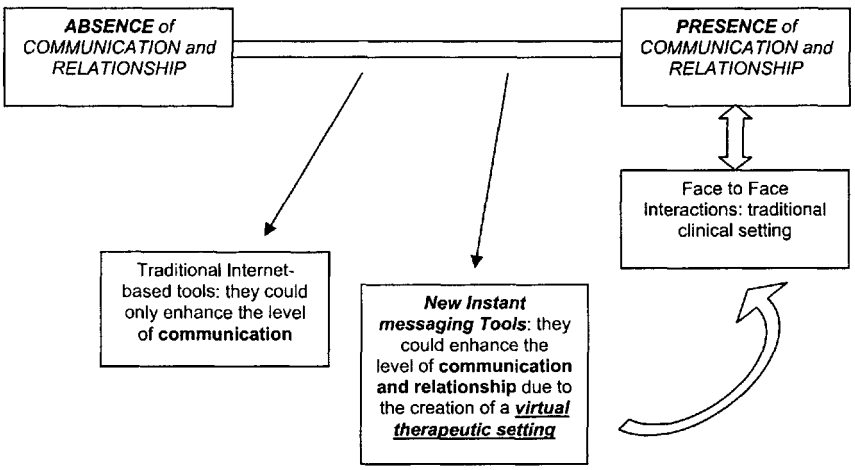

Figure 1. The continuum between absence and presence of communication and relationship in a clinical setting and the possible position of IMs in comparison with traditional Internet-based tools

applications the therapist is able to send the patients files (i.e. assessment questionnaires) and to receive the results even within the same session.

New scenarios about IMs are represented by their integration with the widespread file sharing utilities such as Kazaa, XoloX, WinMX, BearShare, Morpheus, LimeWire, etc. (see http://www.webtechgeek.com/Mp3-File-Sharing-Programs.htm for an interesting review). This peer to peer software allows to download and share files with millions of other users through decentralized peer networks. It is possible to share many types of *media* files or documents, to chat with other users, to browse web pages, to buy on-line, etc. Due to their diffusion and simplicity to install and use, they could represent a new generation of Internet-based tools that could improve IMs. Up to now these peer to peer utilities have been used particularly for music (mp3 and video files) or entertainment (games, software, etc.) but in the next future the peer to peer approach could be fruitfully used in psychotherapy and mental health: possible applications are on-line therapeutic communities or virtual consulting rooms.

Another possible scenario is represented by the VEPSY web site developed inside the VEPSY Updated Project for an integrated treatment of different disorders such as Eating disorders, Anxiety disorders (Social Phobia and Panic Disorders), Sexual Dysfunctions (Male Impotence or Erectile Dysfunctions and Premature Ejaculation). This scenario will be described (from a technical point of view) in the next paragraph as a possible application and integration of the Internet and new technological tools in different steps of the psychotherapeutic iter.

5. The VEPSY web site as a new Internet-based tool for the treatment of different mental disorders

5.1 Introduction

The VEPSY Updated Project has developed a set of services that allow therapists to use Virtual Reality (VR) therapy with patients (for a deeper description of the clinical protocols followed in VR Therapy, please go to the clinical section of this book, section 2).

In particular the VEPSY web site allows to possible users/patients and practitioners to carry on some steps of the therapeutic iter on-line using the tools provided in the web site.

Specifically, the Vepsy we site is a modular VR/Telemedicine clinical platform (software only, working on 56Kbps bandwidth connection and low price portable hardware platforms) for the treatment of the following psychopathologies: Eating disorders, Panic disorders, Sexual Impotence and Social Phobia.

The "primary users"; are the therapists (psychotherapists, psychiatrists, psychologists, physicians, general practitioners, dieticians, urologists) working in private and public sectors, while the patients of therapists represent the "end users".

The VEPSY web site is the "virtual" place where the mental health services are delivered; in particular it manages and delivers applications and software packages to multiple users from a web server across the Internet network. It allows distributing developed modules with downloading technique and represents a powerful tool for online training, in order to keep "professional users" updated.

The web site potential users are the "primary users" and the "end users". Therapists will be able to download tools and software from the web site, and use it as a support for the traditional therapy. Patients will utilize web site services mainly for follow-up therapy.

Both therapists and patients will be able to download the specific software to run VR tools.

Summarizing, Vepsy web site allows to distribute the developed clinical protocols, to support therapists (in traditional therapy) with online tools, to support end users in the follow-up phase, to keep professional users updated (by training online), to promote VEPSY services among professionals, to keep in touch both professionals (via e-mail or chat) and patients (via chat).

5.2 The possible role of the VEPSY Website in the clinical process

Before explaining the technical features that characterize the VEPSY Website, it is important to underline how this tool could be fruitfully included in the traditional clinical process in order to improve some steps of it.

It is important to stress that the evaluation of the clinical and therapeutic efficacy of this new tool inside an integrated protocol need long time and further investigation. Generally the situation of the clinical web pages seem not to be positive due to the lack of guidance regarding desiderable content and operational guidelines [28, 29]. According to Palmiter and Renjilian [29], to date only one published study [28] has tried to evaluate the quality and other relevant features of psychological health care Web sites. As noted in this study, the quality of these Web sites was "not so impressive" (p.1)[28]. In spite of this general low evaluation, different users follow asking health services online and "in comparison to clinicians, consumers also have higher expectations for the content of these sites" (p. 164)[29].

Another issue to stress is that the *VEPSY Website* is not a "self-sufficient" tool that can be used out of (or in competition with) a traditional clinical protocol, but it is only one of the various *old and new* tools practitioners could use according to the particular pathology, social and cultural context, theoretical approach, working alliance, compliance that necessarily characterize the relationship with each patient.

Practitioners have to take into account a lot of variables in order to choose to insert (or not to) the online tools in their clinical protocol: the patient's technical background and the availability of a functional Internet connection are two important conditions to evaluate.

Moreover the possibility to adapt and transform some therapeutic techniques into the cyber setting is another relevant issue: a simple cognitive reframing or a first

assessment could be carried on through an Internet based tool, but a deep psychoanalytic work on personality issues could find low efficacy not in a traditional "physical" setting.
So there are different scenarios for the use of the *VEPSY Website* in each clinical experience. We would like to show four different levels of using it, from a basic scenario where e-tools have a marginal role, to a situation that could be named as *distance therapy.*

1) The VEPSY Website as a simple "meeting point" between therapists and patients. In this basic scenario, the Website has only the goal to make easier the contacts between the different users in the clinical field: after a brief cyber change of information, personal data and availability to start a clinical iter, the core diagnostic and therapeutic process moves to a traditional setting (with a "physical" first session of assessment/treatment in the therapist's office). At this level the registration in the VEPSY Website and the written chat are the most suitable tools.

2) The VEPSY Website as the clinical space to carry on some critical steps of the therapeutic iter. In this second scenario, where e-tools have growing importance, the VEPSY Website could be used for some therapeutic sessions and in particular the first ones (the *assessment phase* with the clinical interview and the administration of diagnostic questionnaires) and the last ones (the *follow-up phase* with periodic contacts between therapist and patients in order to check the evolution of the clinical situations). At this level the written and audio chat, with one or more patients at the same time, could be a fruitful tool for therapists, overall in the follow-up phase. Moreover the possibility to share data and documents (such as questionnaires and relative responses and outcome) through the VEPSY Website could enhance the diagnostic process.

3) The VEPSY Website as a real virtual office where to carry on the most important steps of the therapy. In this third scenario, not only the assessment and follow-up phase could be provided through the Net, but also the other critical therapeutic sessions. Therapists could carry on their clinical work using this cyber setting. For example a practitioner with a cognitive approach could use his/her traditional techniques such as alternative interpretation, label shifting, cognitive reframing, etc. simply communicating through audio and written chat, e-mail and other e-tools. Moreover the possibility to share data and information could enhance the most "cognitive" step of the therapeutic process.

4) The VEPSY Website as a real virtual office where to carry on the Virtual Reality enhanced psychotherapy. In this fourth scenario, the VEPSY Website allows therapists not only to carry on through Internet the traditional methods of each clinical approach (such as cognitive and behavioural techniques), but also to provide the Virtual Reality based component of the new integrated protocols (for a detailed description of this Virtual Reality enhanced clinical protocols, please go to the section 2 of this book). Through the VEPSY website patients can browse the clinical virtual environments according to the indications provided by therapists. All the tools (chat, virtual environments, exchange of documents, etc.) are used in this scenario.

The next paragraphs will describe the technical features of the VEPSY Website, an integrated tool that can be used in different clinical scenarios.

5.3 Overview of the VEPSY Website

Figure 2 shows the home page of Vepsy web site so developed at the end of the VEPSY Updated Project. Vepsy web site "look and feel" had to transmit both a professional feeling

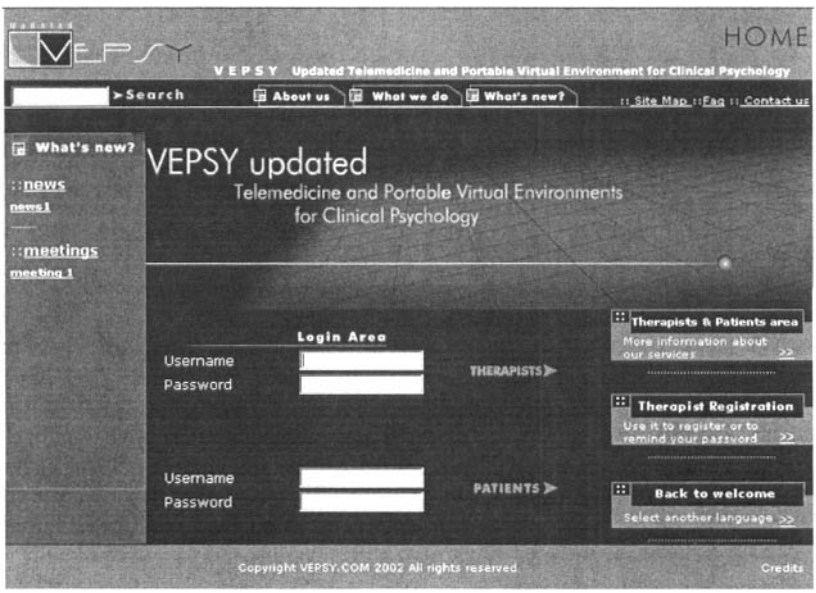

Figure 2. A screenshot of the home page of the VEPSY web site

and a deep sense of quiet; in order to strengthen the Web identity, the blue color as representative color has been chosen.

The blue color, indeed, is the color of silence, of calmness of quiet, of contemplation; for instance, the cardiac heartbeats decrease while seeing blue. This color is also synonymous of control and sobriety and it is the institutional color for excellence. The institutional characteristic of the blue is however softened; by the introduction of some light-blue areas and yellow spots that make the visual emotions lively.

Flash animation also reinforces the identity of the site, capturing the user attention for some seconds.

The site is "therapist oriented" because it is one of the main tools to disseminate and exploit the results of Vepsy Project. This means that therapists will be the real users of the site, and here is the reason of its rational structure and severe look.

The web site is provided in four different languages: English, French, Spanish and Italian and a welcome page introduces the users to the site after selecting the language (it is possible to change the site language only from the home page).

5.4 Internal structure of the VEPSY Website

As shown in Figure 3, the Vepsy web site can be divided in four main publishing areas: Institutional area (yellow), News area (brown), Search-Contact area (red) and Private area (blue).

In the **Institutional area** the Vepsy project, its partners and several types of information about related activity are explained.

The **News area** concerns the information about the latest news and meetings.

The **Search and contact area** concerns tools that help the user in his surfing through the web site.

The **Private area** has been split up into two sections, one for patients and one for therapists.

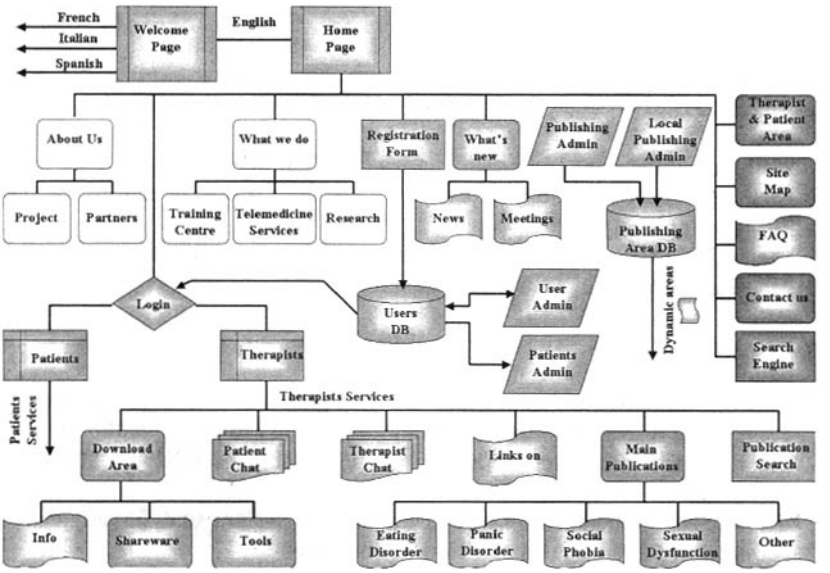

Figure 3. An overview of the internal structure of the VEPSY web site

The user can log in either the "Therapists" or the "Patients" session; it depends on the data entered during the registration.

The Private area is similar for patients and therapists; they have different contents in the "Shareware" and "Tools" sessions (included inside the "Download area") and also have different "Chats" environments.

In both sections there are "Publications", "Publication search", "Download area" and "Links on".

From the "Therapists session" it is possible to enter the patients' chat to allow a therapist to attend patients' chat in order to give expert advice.

5.5 Registration and data base access in the VEPSY Website

The user of Vepsy web site has to be registered before entering the "Private area" in order to be profiled as a therapist or as a patient. In this way, he is recognised by the system that grants him access to the related services.

Therapists only can register directly from the web site.

The first step is to fill in the fields in the "Registration form" and then enter the requested data. The "Username" and the "Nickname" are so checked out by the system, because they have to be unique. If the chosen words already exist, the user will be told to change the "Username" and the "Nickname" and enter new ones.

If all fields are correctly filled out, the user can enter the data that so will be checked and the "Main Administrator" will evaluate the registration request in order to authorize it.

The user will get his temporary password by e-mail and it is advisable to change it. The password is generated by an algorithm and communicated to the user by e-mail, if his registration has been authorized. The e-mail contains user data, his password and news about how to modify the password or get another one (if he/she has forgotten it).

As soon as the user has received the e-mail, he can enter the private he can enter the private area in Vepsy web site.

Each Therapist, after his registration has been accepted, will be able to register his own patients filling in the specific form available in the back end tool.

The registration data are organized in a Data Base. There are two profiles that allow users to access the data:

- ✓ **Main Administrator,** who can display, confirm and delete the data in the Data Base. He can also authorise or reject the registration requests, modify the therapists' profile and disable registered users.
- ✓ **Therapist,** who can only display the data belonged to his patients and can register his own patients filling in a specific form.

To manage data of registered users, the Main Administrator and Therapist have two different interfaces.

Both the Main Administrator and the Therapist can search in the Data Base by filling out these fields: Name, Surname, Country, City and Province

The Main Administrator can also access the data through the fields "Pathology" and "Therapist/Patient".

The logged in therapist is recognized by the system that directly displays the pathology related with him and the file cards of his patients.

The interface also provides the therapists a specific button to register his patients.

5.6 Management and back end in the VEPSY Website

The main feature of Vepsy web site consists in its dynamic parts, which are easily and quickly managed by the back end tool (see Figure 4).

The back end tool is available in English. An exhaustive on-line help will guide the administrator in inserting contents and publishing articles and documents.

The categories are already established and they cannot be deleted, modified or added; they are:

- ✓ **News:** contains articles about the latest information in the medicine, psychology and telemedicine fields. The news has a chronological order, so the last one that has been inserted becomes the first listed. The order cannot be changed.
- ✓ **Meetings:** displays events related with Vepsy partners' activities and others of any interest.
- ✓ **Publications** are scientific articles grouped in five categories:
  - Eating Disorder
  - Panic Disorder
  - Social Phobia
  - Sexual Dysfunctions
  - Others

Thanks to the back end tool, it is possible to order the publications within a category according to importance, so in "Publications" there are listed only three publications,

considered the most important of the section. To look at the other publications, the button "All Publications" is available for each category.

A search among the five categories is possible thanks to the "Publications Search" available in the private area of the web site.

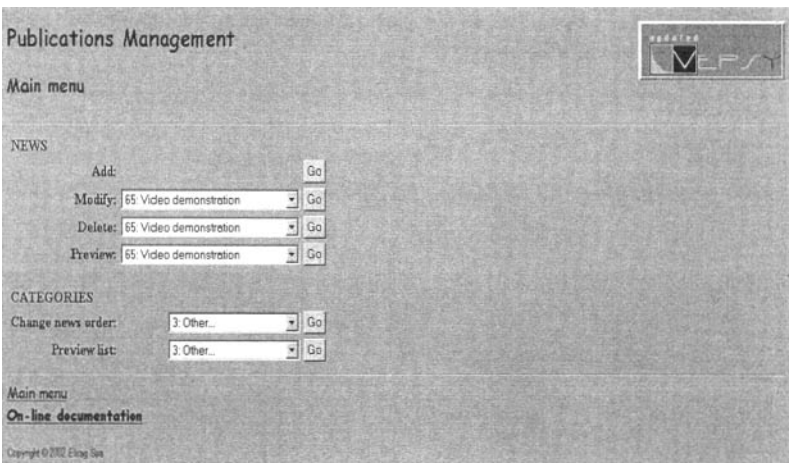

Figure 4. A screenshot of the back end of the VEPSY web site

- ✓ **FAQ**: are the "frequently asked question" about the site and its sections, services and way of use.
- ✓ **Links on:** lists links to sites of interest, which can be related to psychology, telemedicine, medicine and add valuable services for the user.
- ✓ **Instructions** is a section inside the "Download Area" that contains the information useful to understand and use the available software.

In order to publish documents, the dynamic parts are managed by two profiles:

- ✓ **Administrator,** who is allowed to manage and publish into the "English language" session and into the "local language" session of the web site.
- ✓ **Local Administrator,** who can manage and publish only in the "local language" session of the site.

The **Main Administrator**, whenever he wants, can authorise or disable a registered therapist to be an "Administrator" or a "Local Administrator" thanks to a check box inside his file cards.

However, a language bond is required in order to manage the contents of the site correctly in full respect of usability and accessibility.

The publications can be published in the "local language" and in the "English language" sessions, so, for instance, in the "French language" session of the site only publications in French and English can be published.

The other contents of each "language session" of the site (about "News", "Meeting" etc.) have to be strictly in the local language.

5.7 The chat system of chat in the VEPSY Website

Chats are available both in the "Therapist private area" and in the "Patient private area" (see Figure 5). However, therapists can attend patients' chat in order to give expert advice on the subject.

Both chats are also provided with one hall and four restricted rooms, in which users (two or more) can chat in private. In the hall, all users can chat publicly, but it is also possible to start a private link between two users.

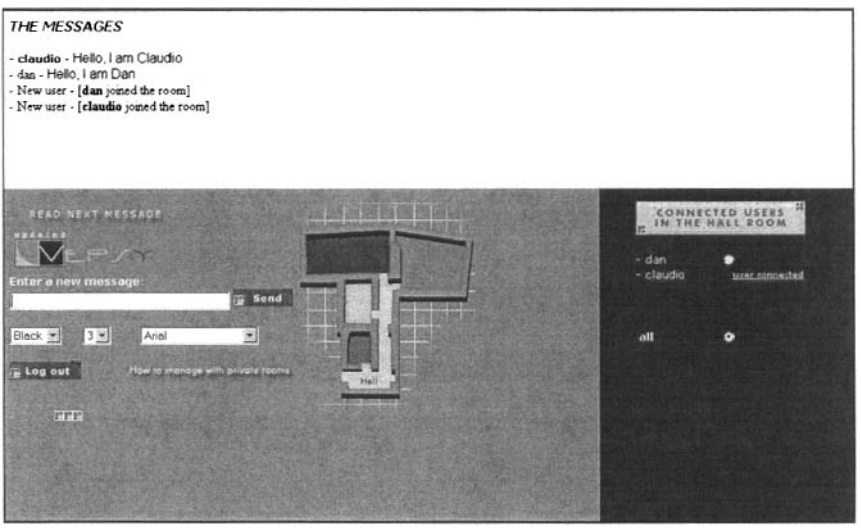

Figure 5. Example of chat in the VEPSY web site

The first user that decides to enter a private room (red, yellow, green and blue rooms are available), has to define a password; the password will be dynamic and will expire when the room is empty again.

To enter one of the private rooms, the user must know the dynamic password and type it.

5.8 Security issues about the VEPSY Website

Other important issues to discuss are related to security, legal protection and ethical aspects [30]. In fact in e-therapy there are different types of relationship (between the clinician and the patient, between clinicians and between the provider of the telemedicine system and the user) [31] in which it is necessary to ensure a system of control and protection.

As noted by Stanberry [31], if "a patient is harmed during a teleconsultation (the healthcare center) could choose to name a number of these organizations or individuals as defendants to a legal action for negligence if it is unclear what went wrong or where responsibilities are" (p. 24).

Although e-therapy (and its tools such as the VEPSY Website) can dissolve the geographical boundaries, "in the case of law, this feature is a potential problem" (p. 559)[15]. Ethical codes have been developed in U.S.A.: relevant examples are the American ACA (American Counseling Association), NBCC (National Board for Certified Counselors) and ISMHO (International Society for Mental Health Online) that try to provide different solutions; for example e-mail encryption packages such as ZipLip or PGP

(Pretty Good Privacy) or web-based e-mail systems such as Hotmail or Hotbot can ensure protection (and confidentiality) and can avoid dispersion of data.
Moreover the verification of the client's identity and the relative procedure to determine if the therapist is licensed, qualified and certified are advised by these ethical codes. Manhal-Baugus underlines that "a site that offers this information is Credential Check (www.mentalhelp.net), which is a neutral third organization that verifies the identity and credentials of on line mental health practitioners" (p. 560)[15].

Most e-mail exchanges between patient and provider involve discussions of personal health information, which must be suitably protected from breaches of confidentiality and from manipulation [32]. However the establishing of a firewall and the introduction of HPC (Health Professional Card) can represent a good solution to avoid the risk of un-authorized access to the hospital server. In general planning all activities in order to ensure data protection is a key factor for the spread of e-therapy [33].

Inside this scenario, analysing web security aspects, some different critical areas have been identified for the VEPSY Website:

1. Web server stored information:

The web server stores information related to therapists, patients, clinical therapies, clinical tests, research activities, clinical training, etc.

2. Data downloaded from web server:

Both training centres and therapists can download clinical data while patients can download clinical modules.

3. Exchange of personal information:

Patients and therapists can send to the web server some personal data, in order to take advantage of the web services; data is supposed to be sent either by mail or in electronic form.

Web security policy will be carried out evaluating these critical areas, particularly:

- Protection of the information stored in the web server from any external intrusion; information must be read, written and modified only by authorised users.
- Security assurance of data integrity and data privacy, so that the content of messages and software packages cannot be intercepted and altered, either maliciously or accidentally. Nobody should be able to eavesdrop or modify information.
- Identification of the owner in order to be sure of data reliability ad information source.

To protect information stored in the web server, the following procedures will be carried out:

- Dedicated areas for registered users:

Each user can enter a private area and benefit by services depending on his user profile (Therapist or Patient).

- Password delivery policy:

A temporary password is sent to the registered user by mail. The user must change its temporary password by using the specific form in the private area of the site. The new password cannot be intercepted because the channel is a "secure channel" (see "SSL digital certificate" below).

- UserId/Password protection:

In order to avoid that userId and password can be read from any system manager, they have been stored after applying a cryptographic technique.

- Firewall protection:

The Service Provider which hosts Vepsy web server (at present Elsag spa) has defined the security policy to protect it from web intrusions. Following the standard criteria for protection, a firewall between Internet and the web server has been installed.

The firewall controls and filters any external access request, according to the applied policy.

Users must have a reliable way to know who owns the services they are using, so they need a proof of the service providers identity. Users want to be sure that personal information they exchange, will not be intercepted by other Internet users. Using a SSL digital certificate is a good way to fulfil these goals.

The SSL protocol enables a web server and a web browser to communicate securely; it also allows the web browser to authenticate the web server.

A user connecting to a web server equipped with a SSL digital certificate is assured of:

- Authentication: the website is really owned by the subject that installed the certificate
- Message privacy: personal information cannot be viewed if intercepted by unauthorized parties
- Message integrity: the data cannot be tampered with over the Internet.

Besides, users can check details in the certificate to be sure that the website they are visiting, is the right one.

Any SSL digital certificate contains the following information:

- The domain for which the certificate was issued
- The owner of the certificate
- The physical location of the owner
- The validity dates of the certificate

6. Conclusion

After the description of the technical features of the VEPSY web site, a practical application of new technologies into psychotherapy, it is necessary to complete this chapter with some final remarks.

E-therapy could be a useful integration between technological tools and traditional clinical techniques and protocols in order to improve the effectiveness and efficiency of psychotherapy. In the near future psychotherapists and psychologists will probably use not only telephone and e-mail (currently the most widespread telehealth instruments), but also tools (such as instant messaging tools) that support advanced communicational features such as real time video and audio connections, exchange of text and video messages etc. [8, 34]

The use of instant messaging has been successful and become accepted practice in many areas of industry, scientific research and medicine, whereas to date new tools do not have the same attention and interest in psychotherapy. E-therapy has been adopted only by few enthusiasts and it is necessary a deep organizational change in Health-care providers in order to obtain a widespread use of e-therapy tools [35]. In particular, changes in consultations and referral patterns, ways of payment, specialist support for primary healthcare, co-operation between primary and secondary healthcare, are needed. [36].

Although the main problem for the success of e-therapy is non-technical [37], but is related to organizational changes, there are technology limitations that should be taken into account [38]: the main limits are represented by insufficient image quality, low framing rate, flickering and delays that make working in front of a video terminal unattractive and tiring. However, the quality of technology in this area is increasing while costs are falling down. Prices are declining by about 25 per cent per year [39].

New transmission technologies, including Digital Subscriber Line (xDSL) and cable modem, promise to provide relevant increases in dependable bandwidth for a small increment of price. For the success of e-therapy applications widespread access to the Internet is also required. Many applications currently demand only moderate bandwidth and latency, meaning that standard modem access to the Internet, at 28.8 to 56 kbit/s may suffice.

To enhance the diffusion of e-therapy further research is needed. More evaluation is required of clinical outcomes, organizational effects, benefits to health-care providers and users, and quality assurance. To date the empirical research is not so strong and spread to objectively evaluate all the benefits and limits of e-therapy [23]. Each Internet technology requires theoretic and empirical research and, on the other side, legal and ethical guidelines to make it safe and effective as an effectiveness and efficient clinical tool. As clearly underlined by Maheu and Gordon, to ensure a high standard of quality "it is crucial for professional psychologists to give proper attention to empirical research and current standards of practice before attempting to deliver counseling or psychotherapy via the Internet" (p. 489).

The VEPSY Website can be considered as a first attempt to create a "virtual setting" where therapists and patients can meet in order to carry on clinical and therapeutic iter. This website has been developed by different professionals (engineers, ergonomists, psychologists, physicians, etc.) and it is important to create *équipe* of professionals with know-how from different areas (in particular from psychological and technological ones) in order to share information, results and ideas. With these multidisciplinary teams, characterized by close cooperation and communication between different professionals, the research about e-therapy can lead to a useful presence of technology in a more and more efficient and effectiveness clinical practice.

Acknowledgment

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3 Virtual Reality and Psychotherapy

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Abstract
Virtual Reality (VR) is a new technology consisting on a graphic environment in which the user, not only has the feeling of being physically present in a virtual world, but he/she can interact with it. The first VR workstations were designed for big companies in order to create environments that simulate certain situations to train professionals. However, at this moment a great expansion of this technology is taking place in several fields, including the area of health. Especially interesting for us is the use of VR as a therapeutic tool in the treatment of psychological disorders. Compared to the "traditional" treatments, VR has many advantages (e.g., it is a protected environment for the patient, he/she can re-experience many times the feared situation, etc.). There are already data on the effectiveness of this technology in the treatment of different psychological disorders; here anxiety disorders, eating disorders and sexual disorders are reviewed. Finally, this chapter ends with some words about the limitations of VR and future perspectives.

1. Introduction

The term Virtual Reality (VR) is quite recent, indeed Jaron Lanier proposed it only a few more that one decade ago. However, in these few years its use has been notably extended and now it can be affirmed that it is a part of our daily vocabulary. This new technology is "getting into" our lives, although we cannot see with clarity yet to which extent it will become important. The only thing we can state by now is that its progress is being dizzy and its possibilities of application are getting more numerous as we will see later in this chapter.

We have already said that the term of VR is a new term, but it cannot be said the same about the tool. Since 30 years ago the scientist community is working on its development. In the sixties its foundations were laid and with no doubt the work carried out by Sutherland in those moments was determinant, pointing out in his doctoral thesis entitled *"Sketchpad: a man-machine graphical communication system"* how computers could be used for making interactive graphics. A few later, this same author [1] published *"A head-mounted three dimensional display"* and showed how graphics generated by a

computer could be combined with visualizations mounted in the user's head. Since the beginning, the tool demonstrated a great usefulness, although the cost was too high being only available for the governments of powerful nations and for very sophisticated development and research programs. Indeed, variants and/or elements of this tool were part of Russian and American spatial programs and helped the astronauts to train systematically and to practice many skills without having to appeal to real situations.

At the beginning of the eighties the tool was still expensive, but the use of images generation systems in real time started to be common in the aeronautical field.[1] The pilots could receive many hours of training in virtual contexts and they could acquire a high degree of mastery in many diverse circumstances. Many of us do not worry about this, but when someone explain it to us, we feel really calmed knowing the fact that any airport and any aeroplane can be digitalized and that pilots can practice taking off and landing in these systems as many times as they want. The same can be said about other situations that imply more o less difficulty or risk. Many of us would also agree in that is better that the pilot has practiced what to do when coping with difficult situations due to fog, wind, technical problems (landing gear, engine failure, etc.) or any other circumstance.

In short, a long time and much effort have been necessary for the technology of computers could develop virtual realities that are useful from a cost-benefit perspective.

The first generation of VR platforms, really immersive, had to be limited to industries and/or research centres where the high cost of the hardware and software development was justified: the aero spatial world, the design world, the building world, etc.

However, at the beginning of the eighties VR is ready to be acknowledged as a feasible technology, and in the end of the decade the first VR commercial systems are available. As Vince points out [2], this can make us to believe that future has arrived. In fact, the topic traps many of us and remains in the imagination of each one of us to delimit what VR might be. In the nineties VR has notably matured. Better and more sophisticated virtual environments and worlds have been generated which can work in much more simple and economical systems and, thereby, they are available for many more users. There are still things to do for this technology to be available for everyone, but in the same way that has happened with computers, as the technological developments progress and costs decrease VR workstations will be available at work, at home in a few time. These workstations will allow us virtual transactions, shopping, games, trips, adventures and meetings [3]. For anyone who gets into this field future possibilities seem not to have limits. Indeed, it has been stated that VR has been during quite a long time an important technology looking for an application [4]. At this moment, we believe that this statement would have to be changed and insist on numerous applications looking for VR.

It is difficult to delimit a general concept of VR that includes all the applications that have been designed up to now under such designation. Nevertheless, it is possible to define VR by the basic concepts that characterize it. One of the first definition of the term that can be useful is given by Burdea, pioneering researcher in this field and with a wide experience in real applications: *"Virtual Reality is a complex user interface that includes simulations in real time through multiple sensorial channels. These sensorial modalities are visual, auditory, tactile, olfactory, etc."* [5].

From the aforementioned definition, it clearly derives that VR is both immersive and interactive. Immersive because through special devices it is achieved that the user has

[1] Before these systems were developed, in the simulators rigid models on the airports and the surrounding environment scale were used with all the difficulties derived from this: the necessity of a big space due to its size, the enormous costs and, therefore, the difficulty of having available separate models of different airports (a generic model was used), in addition to the impossibility of simulating different weather conditions [2].

the sense of being physically present in the virtual or cybernetic world modelled in the system. Interactive due to the fact that VR does not imply a passive visualization of the virtual world, but the user can interact with the virtual world (e.g., he/she can touch and/or move objects) and, what is more important, the virtual world responds in real time to those actions. Interaction and Immersion form the two most important "Is" of VR. However, there exists a third "I" defining VR but to which less weight is given than it actually has.

Such "I" refers to the term Imagination and responds to the fact that VR is not only a good interface, but also offers applications that imply solutions to real problems in so different fields as Engineering, Medicine, Psychology, etc. [6]

2. VR advantages for Psychotherapy

VR is having a great acceptance by clinical community given the enormous potential that offers. Moreover, several research groups have already pointed out its benefits and its possible applications. VR potential makes possible that in a very near future virtually all the clinical disciplines will be able to get benefit of this human-computer interface. The advances carried out since the first works by Sutherland [1] are giving their results and their impact in the health field is going to be more than notable, as is being revealed by the celebration of congresses and scientific meetings specifically addressed to this topic and the publication of new specialised journals in the last years.

From different forums is being revealed, on one hand, the great possibilities that VR can have for health and, on the other, what all this implies with regard to the interchange of knowledge and joint work projects between professionals of very different areas. Basically, engineers and programmers working together with doctors, psychologists and different specialists of the health field with the common aim of developing procedures that might be useful and solve the problems showed by different persons. It is a very important interdisciplinary effort that we think is going to give numerous results.

As for the possible applications of VR to the psychological field, and more specifically to the psychological treatments area, two main reasons for the use of this new tool could be stated. On one hand, VR provides us an incomparable setting for therapy since in this new tool come together many aspects that, traditionally, have been considered central for a good therapeutic process. The "new sense" that is incorporated in "our mechanism to know the world ", if Konrad Lorenz's terminology is used [7], provokes that all those aspects that Korchin and Sands [8] contemplate as "essential ingredients for therapy" are started or activated. On the other hand, it is possible to take advantage of VR versatility in order to optimise therapy itself [9-11].

A few years ago, we already highlighted VR potential in the field of psychological therapies [6, 9] and the facts occurred until now show that said potential was real. All works, carried out in the field of psychological therapies, prove that in less than a decade this new tool has shown a remarkable utility for the treatment of many psychological disorders, as we will show later. Indeed, nowadays VR is of remarkable use, from the point of view of Axis I of the Clinical Guide of the empirically validated therapies, that is, the axis of efficacy or internal validity [12, 13]. However, we think that the great potential of virtual reality is to be considered from the perspective of Axis II of the Clinical Guide or axis of effectiveness. That is, VR has a series of advantages when we compare it with the traditional therapies [6, 14-17]. Let see in more detail the advantages of VR for the psychological treatments field.

1- VR allows structuring therapy like a special and protected environment. The virtual environment is, in fact, a "safe" environment. This aspect of "as if" from VR is of

great importance, as it can be considered to be an intermediate key step between the consulting room (completely protected) and the real environment (totally threatening).

Multiple situations, difficulties, unforeseen events, errors, dramatic consequences can be practiced; although, "in fact", nothing happens. In short, the patient feels safe in the virtual situation and, supported by the therapist, can face the feared context at his own pace and without risks. The fact of understanding therapy as an special and protected environment where the patient can start exploring, experiencing and, in short, acting has a great tradition and a manifest acknowledgement by all therapy orientations and, with no doubt, is part of those "special ingredients" either we call them "myths and rituals" in Frank's terminology [18] or "therapeutic climate and specific therapeutic processes" in Korchin and Sands's words [8].

The inclusion of the virtual environment does not alter anything of what Korchin considers essential for psychotherapy, that is, the belief in the possibility of change, the faith in the therapist as an expert, the positive expectations towards therapy and the motivation to change, the therapist's qualities as a person who inspires reliance and safety, communicates respect and desire for helping, who is able, in short, to get the patient's complete cooperation. However, such scenario adds something new. In our opinion, it can be part of the "therapeutic alliance", and become a third element that has to be relied on. It would mean to include in therapy a difficult world (but still fitting the patient's possibilities) and, little by little, to make the patient able to cope and control the real world from the knowledge and domain of the interactions with several parts of the virtual world.

That "new fitting world" gives also cause for starting or activating what Korchin thinks as specific therapeutic processes: emotional arousal, learning and over learning, self exploration and understanding, reality testing, practice and rehearsal, mastery and successful experiences.

2- In close connection with the aforementioned, is fundamental the fact of acting without feeling threatened (neither by the external world nor by oneself). A good example of this would be the Kelly's "as if" [19]. This point is so important that it is also contemplated, although from a different perspective, in the "safe base" proposed by Bowlby [20], which becomes a central aspect for the configuration of different cognitive structures about the attributes of the self and the world [21]. The therapist can make the patient to understand that the virtual scenario allows him/her to know the situation that he/she has always considered threatening and, moreover, it allows to do it in the way he/she wants, at his/her pace, the time he/she wants... with absolute security of being protected since nothing he/she fears can occur. The virtual scenario is, actually, a "safe base" that therapy offers to the patient and from which he/she can freely explore, experience, feel, live, revive feelings and/or thoughts being these either current or past. Nothing prevents him/her now to become to know the world and him/herself in other way and, in consequence, to start understanding that he/she can function in that new world in different ways than those used until now. Undoubtedly, the assumption of this new perspective generates a great sense of freedom. The person realises that the world and the self that he/she assumed as something absolutely given, fixed, ended, actually (from numerous and important life perspectives) is not more than a simulation, an interpretation that can be altered [22].

3- A basic strategy used, likewise, in all therapy orientations is role-playing. Good examples of this are: Moreno's psychodrama, Wolpe and Lazarus' behavioural role-playing or Kelly's fixed role therapy [19]. The fact of being able to get out of one's own skin and place in some other's person skin or some "other self" (and here we would add some other

context) seems essential to achieve a change of beliefs, or said from Watzlawick's perspective [23], to be able to change an event from one class to another. However, here it is a role-playing version with a special character. They can still be two or more participants (let think, for instance, in a software designed for the treatment of social phobia). One of the participants, the patient, fits classical statements; the other is quite newer, since it implies including the world in the role-playing. The patient has not found a satisfactory way of functioning yet and here he/she is offered the possibility to explore, analyse and try; and, moreover, to feel him/herself doing it. He/she receives non-threatening feedback about his/her performance and experiences it in a clear facilitating and helping environment. In short, it is possible to make the world to assume a new role, which the patient can interact with and, in turn, he/she is going to shape it.

4- It is also necessary to remember how important is for any therapy orientation that the patient copes with (overcomes, assimilates, process, absorbs, etc.) his/her fears. VR allows to grade the situation in such a way that the patient can move forward from the easiest performances to the most difficult ones. Little by little, starting from the knowledge and domain of the interactions with the different parts of the virtual world, he/she will be able to cope with and control the real world. The therapist can make the patient to understand that the virtual scenario allows him/her to know deeply the situation that has always been considered threatening. VR becomes, therefore, a tool to be used for the patient to start knowing and interacting with the feared situation.

5- In close connection with the aforementioned, it has to be pointed out that, from all possible sources of personal efficacy that are contemplated by Bandura [24] in his theory, performance achievements are specially useful. From our point of view, VR is an excellent source of information concerning personal efficacy in the performance achievements ambit, since within the consulting room, numerous contexts for practically assuring the success to the patient in each of his/her "virtual adventures" can be designed and, moreover, difficulties, challenges or occasional failures to be overcome later on by the patient can be planned. According to Bandura, once strong expectations of efficacy have been established through repeated success, the probable negative impact of occasional failures will be reduced. Now then, failures that are overcome with the patient's effort will strengthen his/her persistence and involvement. Obviously, the aim is to achieve the patient discovers through his/her own experience that even the most difficult obstacles disappear by means of a constant and maintained effort. That is, it is of great importance that the patient experiences him/herself as competent, efficacious and with domain. In the same way, it is central to achieve the patient assigns appropriately his/her personal competence to internal factors such as constancy and effort, which will give rise to a larger sense of strength and power on the interaction with the environment [25].

Self-efficacy theory also predicts that, once established, self-efficacy tends to generalize to other situations. Therefore, any advance in the personal functioning can transfer to not only similar situations, but to others that differ essentially from those on which the treatment was focused. As much different and numerous are the circumstances in which the person confronts and dominates any threat, the probability that success experiences give rise to an increase in the sense of personal self-efficacy will be major. It is interesting to underline here that VR is enough flexible to permit the design of different scenarios in which the patient can develop personal efficacy expectations of highest magnitude (including from easy performances to very difficult ones) generalization (referred to very different domains) and, strength (difficult to extinguish, to achieve the patient perseveres regardless of difficulties).

6- It is also necessary to mention the undeniable utility that the use of humour sense can have for therapy. This point has been insistently emphasised by Victor Frankl. The fact that VR allows to construct contexts "as if", that is, less threatening, also involves a higher probability of persuading the patient to "go into" action and to wish with strength, from deep down in his/her heart, that what is so scared of actually happens. If we really manage to convince him/her, we are achieving to set in motion the basic resources that, according to Frankl [26,27], underlie the paradoxical intention: the capacity of spacing out external situations, taking an attitude towards them (self-isolation) and, the capacity of getting ahead of oneself (self transcendence). Moreover, following the recommendations of logotherapy, it would be central to try that the patient experiences the performance of the action, as an interesting adventure in which laugh is possible. That it, to use the unique potentiality for self-isolation inherent to the sense of humour, a potentiality specifically human which can help to attain the "correct passivity" [26], that is, the patient being able to be ironic about his/her problem, instead of escaping from or avoiding it. From a logotherapeutic perspective, the virtual scenario can also facilitate the "perception of meaning", that is, to realise the existing possibilities in the reality setting, or said in other way, to realise what a person can do in relation to a given situation.

7- VR allows a remarkable control of the situation. On one hand, there is no need to wait for the events to be produced in the real world (up to now we could only resort to imagination and role playing) since they can be generated in the software in an increasingly routine way. On the other hand, VR offers enormous possibilities of training, the person can explore and face the feared situations at the pace and speed that he/she requires, and this, will probably potentate treatment results. In addition, VR can help to generalize advances that are achieved in therapy, since it is possible to work in very different scenarios related to the person's problem and also to practice as many times as he/she requires, that is to say, over learning is achievable.

8- Finally, another important advantage of VR is that allows the person to go beyond reality. On one hand, it gives the possibility of changing, altering or modifying the feared context at our convenience. That is VR is enough flexible to permit the designing of a series of contexts in which the patient can affront virtually, not only what he/she fears, but different aspects much more threatening that can be created by means of VR and which would be totally impossible to achieve and control in the real world. For instance, one of our claustrophobia scenarios consists of a wall that moves forwards making a lot of noise and shuts the person in a smaller space. The coping and interaction with the environment can be carried out in many different degrees and in multiple ways until a good domain and over learning is achieved. That is, we can manage the patient to go beyond the feared situation. On the other hand, the goal of VR does not necessarily have to "recreate" the reality. Instead we should worry about delimiting contexts that prove to be therapeutic, that is, "to create" aspects and/or conditions of the environment (which include life information to the patient) to which, by now, the patient does not have access or has lost access [4]

The fact of being able to work repeatedly and at one's pace a certain part of the interaction with the world implies the possibility of "reexperiencing" the implications and consequences of that interaction many times. It is the same that occurs with one of the first and most known applications of VR: flight simulators. Multiple situations, difficulties, incidentals, errors, dramatic consequences can be practiced; although "actually" nothing happens. Progress produced in patient's experience in an always feared (virtual) environment, will help him/her feel, live "the reality" in other way. The main thing is that everything is worked and practised with simulations of the reality which permit generating

new internal models about the world and about the patient's possibilities in his/her interaction with that world [22, 28]. These internal models will help the patient to conform a new level of self-evolution that allows him/her to perceive him/herself and the world from a new perspective.

Apart from all these general advantages of VR, we would like to add some other advantages that VR has when we compare it with traditional exposure therapies [15]. On one hand, compared to imagery exposure, VR exposure is more immersive since VR stimulates several sensorial modalities (e.g., auditory, visual). This might be very helpful for those persons who have difficulties to imagine the feared scenes. Moreover, the therapist can know at any time what the patient is seeing and, thereby he can know more easily what is causing distress or anxiety to the patient. On the other hand, and most significant, compared to in vivo exposure (one of the most effective techniques at the moment), VR exposure can help to surpass many of the limitations this technique has. First, VR can create environments difficult to be accessed in vivo. Second, virtual exposure can also be an alternative for those patients who are reluctant to start and/or complete an in vivo exposure program because they find it too aversive (an aspect related to the Axis II of the Clinical Guide or axis of effectiveness). And finally, VR exposure is also useful from an ethical point of view, offering to the patient a higher degree of confidentiality. This is the case, for instance, of treating an agoraphobic in a public transport, where the public can see the patient getting treated. VR treatment is applied in the therapist's consulting room so the person does not have to be afraid of losing control in front of others or to be worried about someone knowing his/her problem.

3. VR applications in Psychotherapy

The use of VR as a therapeutic tool, in the psychological field, has made a big impact in the last five years. The desire to improve people's quality of life has meant, at the same time, an evolution regarding the instruments used compared to the traditional tools in psychology. And this is not strange, because VR (as we have already seen) can facilitate several tasks that are very important for psychological therapy. Very recently, Hoorn, Konijn and Van der Veer [29] have stated some functions of VR (most of them have been largely mentioned in the anterior paragraph) that we think are translatable to the clinical field: a) VR can be helpful to explore dangerous or impossible events; b) in VR people can explore personal truths to experience their own emotions and comprehend unclear aspects of them relative to contexts in which emotions occur; c) VR helps to re-experience or re-live the past as with family photographs and home videos; d) mediated persons (avatars) in VR fulfil a modelling function in that one learns how to behave in specific circumstances. Furthermore VR may be also useful for entertaining and relaxing, and can satisfy the need for emotional experiences to recompense tedium and listless mess, and which motivate our behaviours [29].

In the revision made for this chapter we will only refer to the most important lines of work in psychological disorders, specifically we will present different works, in which authors have used VR technology for the treatment of anxiety disorders, eating disorders and sexual disorders. However, it is important to point out that relevant interventions have been carried out in other fields related to health with the purpose of improving the quality of life in those people who suffer from certain diseases and illnesses. Examples of this line of work are studies made with patients suffering from cancer both adults [e.g., 30, 31] and children [e.g., 32, 33] and people who suffer from pain and burns of different degrees [e.g., 34, 35].

3.1 Anxiety Disorders

The use of VR as an exposure technique for the treatment of anxiety disorders has been an important line of research that has received a great attention in the last years. As first *antecedents* it should be pointed out, on one hand, a work in which the efficacy of a very rudimentary tool (specifically some special glasses that altered the perception of depth) used by Schneider [36] to magnify the sense of height during in vivo exposure process was tested. On the other hand, deserve mention the first works that recommend the possible usefulness of VR for psychological treatments in general [24] and for the treatment of students' performance anxiety [41].

In the following lines specific advances in VR for the treatment of different anxiety disorders is presented.

- *Acrophobia.* The Kaiser-Permanente Medical Group of California developed a tests system to test the utility of VR in the treatment of acrophobia. In this system the patient has to pass through a depth gully crossing over a suspension bridge and a narrow board. The use of this system in 32 patients gave as a result a 90 per cent of success. Dr. Lamson, the person in charge of this project, stated that patients had the feeling of having coping with this fear and having overcome it, in his own words "it is an excellent tool to get a strong feeling of trust" [37]. Rothbaum and North's group at the University of Clark Atlanta published the first reports (a case report and a controlled study) on the usefulness of a software designed for the treatment of acrophobia in the mid 90s, [38-42]. In 1992 they developed the VREAM (Virtual reality development software package and libraries) by means of which they generated a virtual environment for the treatment of acrophobia. They created a scenario with an exterior elevator that reached to different heights and the patient could lean out of a balcony in every floor. The patient reported feeling a high degree of immersion in the virtual environment and in 8 sessions he could feel relaxed in a height level similar to a 15^{th} floor. Recently, Emmelkamp's group has proved in a controlled study that VR is as effective as the most commonly used choosing method for the treatment of phobias, that is, in vivo exposure [43].

- *Spider phobia.* Firstly, the group at the University of Nottingham and the Institute of Psychiatry has developed a VR system for the treatment of arachnophobia. Patients wear a Head Mounted Display by means of which a virtual spider can be visualized. Its realism is gradually increasing until the patient's tolerance level allows him/her to face the spider in the real world [4]. More recently, Hoffman's group has proved the utility of VR applications for the treatment of arachnophobia using it jointly with augmented reality techniques. These authors have reported on the success obtained in a case report [44] and a controlled study [45].

- *Flying phobia.* Rothbaum's group has designed a software for the treatment of fear of flying. In a case report, this group informed on the utility of this procedure applied along 6 sessions with a duration of approximately 35-45 min. to a woman of 42 years old suffering from a severe fear of flying [46]. More recently, Rothbaum's group has tested the efficacy of virtual exposure therapy versus in vivo exposure in a controlled study [47]. Two years later, this group has published the first year-long follow-up of patients having been treated with VR exposure and results indicate that short-term treatment can have lasting effects [48]. Many other authors have also obtained good results using VR for the treatment of this phobia [49, 50, 42, 51]. Our

group has also developed a software for the treatment of flying phobia [52] and has demonstrated the utility of the procedure [53, 54].

- *Claustrophobia.* Our group has designed a software for the treatment of claustrophobia [55]. Results obtained in a case report have shown the utility of this procedure applied along 8 individual VR graded exposure sessions [56]. In other work, changes in other phobic behaviors not specifically treated were also obtained by using the same procedure [57]. Moreover, these results have been supported in other two studies; a case study [58] and a controlled multiple baseline design [59]. Therefore, we can already state that the claustrophobic virtual context is able to produce a remarkable amount of anxiety in patients, who can overcome the phobia with this virtual exposure treatment.

- *Post-traumatic stress disorder.* VR has also been used for the treatment of post-traumatic stress disorder. Hodges and Rothbaum have developed the first software and Vietnam War veterans are being treated by means of virtual scenarios that reproduce war images. They have already presented the results of a case study, where the first Vietnam combat veteran with post-traumatic stress disorder is treated with VR exposure [60], and a clinical trial [61] both with including 6-month follow-up data. The authors conclude that VR exposure therapy holds promise for treating post-traumatic stress disorders in Vietnam veterans. VR is also being used with people affected by the September 11 attacks.

- *Social phobia.* North's group at the University of Clark Atlanta is studying the usefulness of VR for the treatment of fear of public speaking. The person is immersed in a virtual scenario and while he/she is giving his/her speech the audience in front of him/her becomes gradually clearer resembling to a real audience. Rothbaum's group has also developed a procedure for treating this specific phobia and, in England, Slater [62] has been working on a software designed for this problem and on its validation [63]. On the other hand, Lee, Ku, Jang, Kim, Choi, Kim and Kim [64], have designed a virtual environment more realistic for the treatment of fear of public speaking by using image-based rendering and chroma keying simultaneously. With image-based rendering, images are stitched panoramically with the photos taken from a digital camera and the use of chroma keying allows a virtual audience to be controlled individually. Our group has developed a self-applied program that uses self-help tactics and telepsychology techniques for treating public speaking phobia. This program can be entirely self-applied by internet (http://www.Internetmeayuda.com) and has been clinically validated obtaining very good results [65-67]. On the other hand, Legeron's group has developed a VR program for the treatment of social phobia in the Telemedicine and Portable Virtual Environment in Clinical Psychology (VEPSY Updated) research project. A detailed description of this program is presented in a chapter of this book.

- *Driving phobia.* Preliminary studies have been done for treating driving phobia [68]. A case report has proved that VR can also be useful for the treatment of this disorder [69].

- *Panic Disorder and Agoraphobia.* North's group developed a software for treating agoraphobia and put it into practice in a subclinical population [42]. The results

showed that students in the virtual exposure condition improved in a significant way compared to a control group. However, the software developed by this group does not cover appropriately the whole cluster of fears that characterizes panic and agoraphobia disorders and the participants in this study were subclinical population. More recently, Jang, Ku, Shin, Choi, and Kim [70] have used a VR scene in seven patients in order to tackle the situations that people (who suffer agoraphobia) fear the most, but patients had difficulties with feeling immersed in the virtual world. Maybe the virtual environment could not activate user's anxiety. Moore, Wiederhold, Wiederhold and Riva [71] have used panic and agoraphobia virtual environments to determinate the physiological responses of nonphobics. According to these authors, it will be useful to explore differences between immersion, physiological responses, and self-report responses in nonphobics versus phobics. Our group has been working during the last years on designing a procedure that may prove useful for this important disorder in the setting of the VEPSY-Updated research project. We have developed and tested a software that covers nearly all the typical situations of the following cluster of phobias: panic attacks and agoraphobia. The program also gives an additional advantage since it is possible to simulate many physical sensations that people feel during their panic attacks (such as shortness of breath, blurred vision or tunnel vision) by using sounds and optical effects and, therefore, it is possible to use interceptive exposure, while exposure to external stimuli is taking place. The program has shown similar effectiveness to that achieved by in vivo exposure [72, 73]. In a chapter of this book more information about this program is offered.

3.2 Eating Disorders

Eating disorders (anorexia, bulimia and compulsive eating disorder) make up a complex diagnostic category that usually entails a serious state. One of the most serious psychological problems, present in the vulnerability, in the maintenance and in the relapses of these disorders, refers to perceptual distortions of the body image. This is an aspect that proves difficult to evaluate and to treat with the traditional psychological techniques. VR has become a new therapeutic tool that is being used more and more in these types of disorders. Riva, Bacchetta, Baruffi, Rinaldi and Molinari [74] presented a treatment for changing body image disturbances in persons with distortion and problems of not accepting their body, but without suffering the disorder. They used VEBIM (Virtual Environments for Body Image Modification), an immersive virtual environment that incorporates a cognitive behavioural therapy (in order to have an influence on the sensations of dissatisfaction) and a visual-motor therapy (to intervene in body perception levels). Later works [75-80] have confirmed the effectiveness of this therapeutic tool in eating habits with excellent results. Nevertheless, other psychological techniques have been proposed in conjunction with these technologies. Neubeck and Neubeck (1998) point to VR as one more support system, along with the psychodynamic treatment. It is used in anorexia nervosa cases and they combine VR, in the area of psychodrama, with psychodynamic theory obtaining good and more stable results.

This evaluation system was later compared to the VREPAR2 project, directed by Riva, Bacchetta, Baruffi, Defrance, Gatti, Galimberti, Nuges, Ferretti and Tonci [81], which includes a cognitive behavioural therapy aimed at exercising an influence on the sensations of body non acceptance and a methodology that joins the videorecording of particular gestures and movements that try to have an influence on the body perception level. The authors highlight the fact that in comparison to the traditional therapy, in which a

longer treatment is needed, VREPAR2 obtains effective results in a very short period of time. Later, Riva, Bacchetta, Cesa, Conti, Molinari [82] betted on the joint use of VR, telemedicine and experimental cognitive therapy (ECT) aimed at eating disorders, being effective for the motivation of body change. Former studies back these therapeutic tools for this psychological problem. Nevertheless, Murray and Gordon [83] obtained different results in similar studies to those of Riva, they did research on the body perception changes induced by the immersive VR, and they compared immersive and non-immersive environments. The results showed significant effects in both states, but there were no differences in sex or the condition of presentation. The results showed that immersive VR users showed a smaller level of conscious body self-perception. Nonetheless, it is necessary to point out the fact that Riva usually worked with VR cognitive therapy, thus the methodology used is different. The VR program for the treatment of eating disorders developed by Riva's group in the setting of the VEPSY-Updated project is fully described in a chapter of this book.

VR environments have also been used in the evaluation process. Riva [84] created a scale for the psychological evaluation of the body image, called *Body Image Virtual Reality Scale* (BIVRS). This scale is aimed at making people value their actual body obesity while they are immersed in the virtual environment and then choose the ideal body combining the discrepancy levels of non acceptance of their body.

In spite of the results reached by Murray and Gordon [83], other studies have obtained very beneficial therapy results for the treatment of eating disorders with VR.

Specifically, our group has designed a VR software composed by several scenarios for the treatment of body image disturbance in eating disorders [85, 86]. We have carried out a controlled study conducted in a clinical population, which consisted of a comparison of the efficacy of a VR component versus the traditional body image techniques [87].

Results showed, once again, the effectiveness of VR therapy for eating disorders.

Differences in the measures of eating disorders were no found; however, patients treated with VR showed a notable improvement both in depression and anxiety and a greater satisfaction with their bodies. Therefore, it was concluded that these results reveal that VR therapy is more effective than other traditional techniques for treating body image distortion in eating disorders.

Later, new methods have been suggested, but following the guidelines of other previously mentioned experiences. Alcañiz, Botella, Perpiñá, Baños, Lozano, Montesa, García-Palacios and Villa [88] presented a deformed model of a human body in 3D which they used with eating disorder patients. Patients were able to express how they perceived their own body with this method. Finally, very recently we have published a work where a pilot study in the area of body image disturbance and binge eating disorder using VR technology is described [89].

3.3 Sexual Disorders

Virtual environments have also been used for sexual disorders. Optale, Munari, Nasta, Pianon, Baldaro and Viggiano [90] carried out a treatment study on VR for treating impotence and premature ejaculation. The patients, who had benefits from the technique informed on a lasting improvement after a six-month therapy. In another study on sexual therapy, Optale, Chierichetti, Munari, Nasta, Pianon, Viggiano and Ferlin [91] studied the psychodynamic therapy along with the study of brain connections through a PET (Positron Emission Tomography). Results showed alterations in the metabolic function of the brain, in the frontal cortex and in the thalamus, the researchers also achieved a sexual satisfaction after therapy. These authors indicated that these brain areas seem to answer the combined

therapy of VR and psychotherapy. The VR program developed by Optale's group for the treatment of impotence and premature ejaculation in the setting of VEPSY Updated project is described in a chapter of this book.

On the other hand, it is necessary to point out in this section the fact that new technologies are favouring the appearance of new disorders in sexual behaviour. We are referring to what is usually known as cybersex since cases of "virtual sex" addiction are already being registered. In this sense, Delmonico and Carnes [92], who did research on this subject, recommend the use of a psychological test, the Internet Sex Screening Test, with the aim of evaluating if some people need help due to this addiction.

4. VR shortcomings

We do not want to finish this work without making a prudent attempt of "back to reality" as we already did in a past work about virtual reality and psychotherapy some years ago [6].

We defended then and we do now (and will keep defending in the future) the possible contributions that VR can have for the psychological treatments field.

Nevertheless, as we pointed out in that work, it is important not to confuse facts with fiction and the available facts reveal the convenience of indicating the shortcomings that this new tool has for the moment. We will see that some of the limitations indicated in 1998 have been improved or overcome.

- *The virtual world is still rudimentary.* The first virtual scenarios made of very simple textures and still quite artificial remember the cinema industry at the beginning with those fast movies of a unique shot and without sound. Nevertheless, nowadays this cannot be stated since in these few years a number of researchers are working in order to get a higher degree of realism and, it can be said that the very fast development of technology is allowing to construct more and more realistic environments which are being more efficacious to immerse the self in the virtual world. Moreover, other line of work that is receiving attention is trying to determine what psychological factors (or other kind) could be influencing the sense of presence and the reality judgement the person makes of the virtual environment. As for clinical population, results obtained by Baños, Botella, García-Palacios, Perpiñá, Quero and Gallardo [93] point out that in the VR application for clinical psychology, emotion seems to play an important role in the sense of presence and the reality attributions of users. Indeed, our group is currently developing a research project on the relation between emotion and presence, funded by the European Commission (EMMA: Engaging Media for Mental Health Applications) (http://www.emma.upv.es). Anyway, more research is needed about these issues bearing in mind that the main thing probably is to develop virtual environments clinically significant to the patients.

- *VR has clear limits.* Although the person can "live" the virtual experience many times, it is only an "adventure" from which he/she comes back to reality or from which it might be difficult to come back. Related to this, it is necessary to delimit the probable prejudicial effects stemmed from a misuse of VR.

- *VR can produce secondary effects.* In connection with the anterior point, it has been pointed out that virtual walks can produce secondary effects, basically disorientation and neural-vegetative symptoms (e.g., dizziness, nausea ...) and, in a lesser extent,

some ocular-motor disturbance. However, studies where it is indicated how to minimise and control these disturbances or prevent them have been carried out [94]. Nevertheless, these problems are not always produced and, besides it has been reported about the lack of these negative effects and, therefore, about the possibility of using VR techniques with clinical samples suffering from severe disorders such as anorexia or bulimia nervosa [95]. Hopefully these efforts give rise in a few time to systems which can be considered "safe" for future users. As clinicians we keep alert to the possible collateral effects that might be produced, although results obtained up to now reveal that these effects are very infrequent.

- *More data regarding VR efficacy are needed.* As can be derived from the literature revision of the applications and effectiveness of VR for anxiety disorders, eating disorders and sexual disorders presented in the anterior point of this chapter, this statement has changed after five years. Studies carried out up to now are finding that VR is not only an efficacious technique for the treatment of several anxiety disorders and central clinical aspects (specifically the body image distortion) of more severe disorders such as eating disorders, but VR techniques are obtaining better results compared to other traditional techniques of wide use (e.g., in vivo exposure). However, more controlled research is still needed to draw more firm conclusions, especially with regard to the great potential that VR might have from the perspective of Axis II of the Clinical Guide or axis of effectiveness.

- *VR is a new tool and a great part of the work remains to be done.* Although as we have already pointed out, the use of VR as a therapeutic tool in the psychological field has made a big impact in the last five years, we think this statement is still right. We cannot forget that this so interesting line of research has started only a few more than a decade ago, thereby many things remain to be done. A fundamental aspect of this work, still non-existent, is to structure a theoretical framework from which predictions can be made and results can be organised.

5. Future perspectives

In our view, VR has a great future and the applications appeared up till now are the beginning of a huge development that will take place in the coming years. As we have already pointed out, it is difficult to think of an application that cannot be created by using the technology currently existing; the problem of doing it is just a matter of time and money. The main point then changes to: in which fields to work?, what applications can have more sense or be more useful, have more impact to benefit more people? [96]. This challenge about what psychological cyberspace is convenient to be created affects all of us.

Although it is being made a lot of research on VR, many things remain to be done.

This becomes very obvious when, for instance, psychological applications are compared to those of medicine and surgery. However, the applications of VR to psychological treatments field are increasingly developing with its own identity and presence in the health area. And this is due to the fact that VR provides the possibility of adding, removing or emphasising details that help the clinical psychologist to perform his/her basic duties in a better way. These characteristics of VR can provide the patient specialised and safer assessment and treatment techniques for problems which up till now were very costly or even impossible to be evaluated or treated by means of traditional methods. For these reasons, VR is producing a great interest and is being given a great attention from Clinical Psychology.

Nevertheless, this interest and attention must be guided. We must avoid an excessive and useless growth that might take us into unproductive grounds. Indeed, one of the big problems we might find is to start designing or developing products that become "a solution looking for a problem". We never must forget that there are no answers by themselves, but there are answers to questions and that VR maybe cannot offer us the way of making questions. The psychologist will always must do this, or at least in the world how we understand it currently.

Therefore, to create a useful application for Clinical Psychology at present, we first would have to ask ourselves: what can be it used for? It has to be emphasised that technical characteristics of virtual worlds change very rapidly, but what does not change and will never change is the user of virtual reality. For that, it is important that before starting designing VR applications we make to ourselves the following basic questions: It can be achieved the same objective by using a more simple approach? And how VR approach can be fitted to the features of the target clinical population?

In conclusion, at present VR has shown that it can be very useful in the treatment of many psychological problems. And, most important is the fact that VR can be effective with relatively cheap hardware and software on stand-alone computers currently on the market [e.g., 43]. So we think that in the next years VR can turn into a key tool and not only because of its effectiveness, which is very important, but also because of the advantages it offers in comparison to other therapies. If the VR field keeps up the development speed it has had up to now, in a few years VR can be in all clinical consulting rooms. Indeed, we expect to happen in Clinical Psychology the same thing that has happened during the past fifty years in Medicine. It is now unthinkable that for many problems medicine does not have a series of sophisticated and expensive tools that enable doctors a more precise diagnosis and intervention. It is true that VR implies an economical investment. But if benefits obtained with VR are adequate, from a cost-benefit perspective, VR will be cost-effective. With VR, the new technologies have definitely entered the field of psychological therapies.

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4 Virtual interaction in cognitive neuropsychology

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Abstract Several recent studies have investigated whether knowledge representation turns possible within virtual reality simulated environments. According to these affirmative results different clinical applications were developed in psychology. Among these applications virtual reality seems to have a specific role in assessment and treatment of neuropsychological diseases. This chapter will firstly investigate possibilities and challenges carried from virtual-reality-based neuropsychological application focusing both on patient's and therapist's point of view. Afterward it will provide a survey of research and intervention application examples. More in detail a clear explanation of contribution goals will be discussed, in order to place research and applied works within a cognitive neuroscience frame of reference, according with their usefulness and effectiveness in clinical treatment. Fulfilling these objectives neuropsychological virtual reality approaches in memory, motor abilities, executive functions and spatial representation will be shown.

1. Cognitive neuropsychology assessment and rehabilitation

Cognitive neuropsychology can be thought of as a specific discipline within cognitive psychology. In particular:

"*Neuropsychology is cognitive to the extent that it purports to clarify the mechanisms of cognitive functions such as thinking, reading, writing, speaking, recognising, or remembering, using evidence from neuropathology*" [1].

According to this purpose cognitive neuropsychology will use evidence about the selective breakdown of specific cognitive domains (e.g. memory, language, visual cognition, praxis) in a variety of neurodegenerative disorders to (a) examine the functional neuroanatomy underpinning those cognitive domains and (b) explore the implications of focal cognitive deficits in neurological patients for models of normal cognitive function.

A variety of central nervous system (CNS) dysfunctions may produce cognitive and functional impairments in human behaviours. Traumatic brain injury is the most frequent causes, and the resulting impairments commonly involve processes of attention, memory, language, spatial abilities, higher reasoning, and functional abilities. Moreover significant emotional and social, components generally co-occur and can also further complicate these areas.

Because of the pervasive nature cognitive dysfunction, the cost to individuals and society is significant.

Neuropsychology, as applied science, has evaluated what are the specific activities in the CNS that are linked with observable behaviours [2]. Furthermore neuropsychological assessment constitutes the fundamental approach for both the treatment and the scientific analysis of any CNS-based cognitive/functional impairment. A neuropsychological evaluation is a comprehensive assessment of cognitive and behavioral functions using a set of standardized tests and procedures. Various mental functions are systematically tested, including, but not limited to reasoning, language and perception. Neuropsychological evaluation can assist greatly in planning a had-hoc rehabilitative strategy in cognitive function recovery after brain injury. A measurement of treatment efficacy is also possible through neuropsychological evaluation in different follow-up periods. Finally it can also be invaluable for disability determination or for forensic (legal) purposes.

Classical approach to neuropsychological assessment was generally based on the use of pencil and paper tests and the measurement of cognitive/functional processes was based on two criteria: reliability and validity. The first is due to the capacity of consistently return the same results in evaluation, the second is concerned with how well an instrument actually measures what it purports to measure. Traditional tests present the neuropsychologist with both reliability and validity problems. The variability of administration procedures, due to differences in examiners or to the difference of stimuli presented can invalidate the reliability of traditional neuropsychological evaluation. Furthermore, the fact that some tests require multiple cognitive domains for successful completion could attenuate the validity of traditional assessment methods because it remains unclear what specific cognitive domain is being evaluated. Finally, "paper and pencil" neuropsychological testing has a limited *ecological* validity such as the degree of relevance that a test has relative to complex performance in an "everyday" functional environment [3].

In paragraph 2 it will be possible to understand how these problems may be avoided using virtual reality simulation in neuropsychological evaluation and treatment.

For how concerns clinical treatment, neuropsychological approach to rehabilitation aims to reduce cognitive disability in patients with acquired brain damage. Both cognitive processes and functional activities of daily living are typically targeted with this kind of intervention. Underlying the goals of both of these treatment areas is the concept of neural *plasticity*, such as the capacity of the brain to reorganize or repair itself following injury.

Brain plasticity is possible through various mechanisms (i.e., axonal sprouting, glial cell activation, denervation supersensitivity, and metabolic changes) and occurs in response to environmental stimulation [4]. If this view is accepted, stimulating training environments would seem able to support rehabilitative process and new approaches to cognitive rehabilitation would be warranted. Consequently, it can be appreciated that the stimulation or "enrichment" provided by neuro-rehabilitation approach may have some effect on the physical brain structure, and hence, training with well suited rehabilitative protocols would be assumed to positively affect brain plasticity.

Cognitive rehabilitation approaches can differ based on a variety of conceptual criteria [5]. According to Rizzo and colleagues [6] these conceptual dimensions can be resumed into two general domains: *Restorative* approaches that focus on the systematic cognitive processes retraining and *Functional* approaches that emphasize the training of observable behaviours. Both these approaches to rehabilitation have different methods and goals. The primary objective of the restorative approach is to retrain individuals how to plan and ideate behaviours, whereas the emphasis of the functional approach is to teach individuals how to perform day-to-day activities. Specific weaknesses have been identified in both of these approaches. For restorative methods criticisms are focusing on is the reliance on test materials and on the lack of generalization of ability to the person's real-world situation [7, 8]. The fundamental criticism of functional methods is that the learning

of procedures has to assume that patient lives in a static world where life demands do not change [5].

In paragraph 3 it will be possible to see how the application of VE technology for the rehabilitation of cognitive/functional deficits could serve to limit the major weaknesses of both the restorative and functional approaches, and actually produce a systematic treatment method that would integrate the best features from both methods.

2. Virtual Reality in cognitive neuropsychology

Along with interactive technologies growth, and in particular with virtual reality diffusion, a possible perspectives modification for the assessment and rehabilitation of cognitive functions turns possible. Several researchers agree in underline how virtual reality (VR) should allow the development of suitable and extremely useful virtual environments for cognitive functions rehabilitation [9, 10, 11, 12].

The main innovation carried out from VR is on the possibility in having a new human-interaction type. All user body movements should become potentially very important during the interaction with a virtual environment (VE), within which all the modification in the VE will change back a new action opportunity for the same user. In any case VE doesn't have to be considered equivalent to the "natural" environments, but environments trough which is possible to have obvious experiences well designed for our goals. A virtual environment even remains something different from a real environment [13].

Determinants that contribute on increasing attention in using interactive-computerized simulations, such as VR, in neuropsychology are various. First of all VR allows the creation of a completely multimodal patient stimulation that will be able to supply patients, by a completely immersive interaction with VE, with a great sense of involvement in action, generally defined *presence* [14, 15]. Just presence is assumed to be essential for the acquisition and recovery of complex behaviours. According to this, VR interfaces developed for neuropsychology were ideated in order to be able to support a reality judgment or a plausibility impression towards actions that patients are performing within simulated worlds.

Furthermore supporting virtual reality introduction in rehabilitation, several recent studies show how not only knowledge acquisition will be possible in VR but also how this acquired knowledge could be transfer in a real environment [16]. This evidence adds value on VR use in highly social disabling cognitive functions rehabilitation, highlighting how goals reached in controlled settings may be transfer on patients' everyday life.

2. Why use it and why not

In the last ten years several researches have contributing in develop guidelines for the creation of useful tools in neuropsychological rehabilitation [17, 18]. Among these, applications have left off the use of very expansive and awkward technologically advanced systems in order to focus attention on VR systems and giving the possibility of enhance patient with an high action involvement sense, even through simpler interfaces.

Furthermore, it has spread the inclination on creating ergonomically optimized systems in order to easily use it with cognitive-motor impaired people. Finally it has started to provide for the possibility of create VR systems flexibly conveyable in order to allow a continuous rehabilitative course even out of medical structures without disclaiming in have control possibility on treatment propriety (e.g. tele-assistance).

Main advantages in innovative technology use in cognitive and motor functions assessment and treatment may be resumed in three main aspects. First of all, VR systems allow to potentially have in input all patient actions and are also able to transform these action in different ones within the virtual environment (VE). This aspect turns to be very highly-prized in patients who have the necessity of substitute impaired actions with alternative movement possibilities, such as in hemiparetic patients. Furthermore, VR systems can provide multimodal stimulation that, firstly, avoids in over-stimulate the perceptive system, and also allows to provide patients with behaviour cues on multiple or alternate sensory ways. This will support more accurate knowledge integration and an efficient learning.

Finally, virtual environments give the opportunity of situate patients within settings that in not simulated environment could be unapproachable, dangerous or stressful for them.

More in details VR allows new opportunities for evaluation and treatment of neuropsychological disorders generally not available with traditional methods [19]. Using virtual environments, in fact, it is possible to provide patients with "ecologically-like" situations that could enhance even more efficient goal oriented planning behaviours in rehabilitative tasks performances. Moreover, the immersive experience in VR induces patients in forgetting they are involved in evaluative or training session, supporting a more spontaneous performance. This aspect turns VR-based treatment an effective user-centred training approach, even more because patients may have a detailed monitoring of rehabilitative progresses they are reaching. According to these advances is possible to obtain a congruous therapy modification. VR training settings made able patients in acting within a safety environment firstly avoiding anxiety linked to particular performances, thus enhancing confidence in action execution and finally increasing motivation improving autonomy within everyday-like situation. Moreover acting in a sheltered scenario made patients aware of limitations the pathology cause them and of risk he/she could run up against with and imprudent conduct, such as cross the street or moving around within the kitchen.

If accepted in a focused rehabilitative protocol and not used like *entertainment* VR tools are able to conciliate a playing aspect spread from computerized interfaces with efficacious treatments enhancing patient's motivation in pursue therapy.

VR Application	Benefits	Challenges
Neuro-muscular	o Improved Compliance o Fine time resolution o Rehabilitation at home o On-line data gathering	o Equipment cost o Technical expertise o Safety at home o Network bandwidth
Post-Stroke	o Engaging/motivating o Repetitive intensive o Adaptable to patient condition o Usable in chronic phase o Activities of daily living	o Clinical acceptance o Technical expertise o Abnormal limb configuration o Upper functional population applicability o Cognitive load
Cognitive functions	o More realistic assessment o Reduced therapy cost o Increased safety o Learning transfer	o Equipment cost o Safety at home o Psychological factors

Figure 1. Benefit/challenges in VR neurological applications

In spite of its benefits, rehabilitation in VR already shows significant challenges for its adoption. First of all, for the function recovery treatment efficacy, there is a clinical non-acceptance of VR based or VR augmented rehabilitative protocols necessity. Medical and cognitive rehabilitative studies are still underway and not definitive data actually exist on VR rehabilitation effectiveness. However it should be said that in initial data collected with post-stroke chronic patients VR has been shown to improve performances even long after any classical therapy stopped [20]. Another important challenge is supported by the idea that virtual rehabilitation should replace the therapist altogether with computers, whereas VR will be a precious tool for therapists, allowing them to do more with more patients.

Finally there is a technology gap that increases resistances to computer based application. VR interfaces and particular devices are something therapist and users are not generally familiar with, but if "forced" in using VR interfaces patients and their relatives show a clear enthusiasm in embracing such type of rehabilitation.

In spite of VR approaches benefit/challenges comparison, resumed in Figure 1, it seems very important to investigate and develop innovative rehabilitative techniques, supported from advanced technologies, in order to improve the recovery of cognitive and motor functions in neurological patients.

3. How to use it

Considering differences with VR interaction in healthy subjects, it is not difficult to understand how rehabilitative approaches had to focus on particular type of VR interfaces that will be able to support motor and cognitive function's recovery. In doing this VR systems had to be very flexible in order to accommodate themselves according to variety of deficits that could be present among patients and even in patients with same diagnosis.

Up to now evaluative and rehabilitative VR application were, on one site, generally oriented to run an assessment of innovative technologies efficacy and, on the other site, specifically focused on impaired function rehabilitation. From the survey carried out below, it will possible to see how different approaches in VR application were provided.

According with assessment-rehabilitative protocol used it will be possible distinguish between a VR-augmented clinical application (in which patients receive "classical" exercises combined whit VR exposure sessions) and a VR-based clinical application (the newer approach in which "classical exercises are eliminated and substituted entirely whit VR interactions). These different approaches imply different methodological choices and, how we'll see afterwards, will conduct researcher to different conclusions on VR efficacy.

VR clinical application will be explained according to cognitive function they are addressed for, such as memory, plan and/or motor abilities, executive functions and knowledge representation.

Table 1 will resume VR application for the evaluation and training of impaired cognitive functions.

4. Memory VR applications

Memory disorders are one of the most disabling consequences of acquired brain injury and according to this cognitive rehabilitation programs had largely focused on it. There are, in fact, many "paper and pencil" neuropsychological assessment tests to measure such cognitive functions. Unfortunately, even if they are specifically devised to measure different forms of memory, they were been criticized as lacking in measure everyday

Table 1. Virtual Reality applications in cognitive neuropsychology

INTERVENTION	APPLICATION	AUTORS	GOAL	CONCLUSION
MEMORY	Assessment	Brooks et al. 2002	Perspective memory evaluation	VR as interesting tool
		Andrews et al. 1995	Comparison of incidental memory in active/passive interaction	VR as good instrument for incidental memory assessment
	Rehabilitation	Brooks et al. 1999	"Error free" memory recovery approach	VR for error prevention
		Glisky et al. 1994	Vanishing cues method for memory rehabilitation	VR can provide information that could be reduced according to progresses
PLAN AND MOTOR ABILITIES	Assessment	Rose et al. 1998	Monitor patient's reaction to specific stimuli	VR for selective motor response evaluation
		Broeren et al. 2002	Haptic stimulation importance	VR as test method for functional motor skills
	Rehabilitation	Wilson et al. 1997	Support patient in action performance	VR turns patient autonomous in everyday environment
		Morganti et al. 2003	How VR can support action simulation process in motor rehabilitation	VR can support active construction of motor plans in stroke patients
		Zang et al 2001	Is VR-based motor rehabilitation transferable to real environment?	VR tools for everyday performance recovery training
		Holden and Todorov, 2002	The importance of augmented feedback in VR rehabilitation	VR training shows a great improvement in motor rehabilitation
EXECUTIVE FUNCTIONS	Assessment	Lo Priore et al, 2003	Dysexecutive syndrome assessment in VR	VR for training in objects recognition and use
SPATIAL KNOWLEDGE REPRESENTATION	Assessment	McGee et al., 2000	A comparison between traditional assessment and VR-based one	VR as effective assessment tool for spatial knowledge
		Morris et al 2002	Egocentric/ allocentric spatial memory	VR allow combination of egocentric and allocentric tasks in the same session
		Maringelli et al. 2001	Attention assessment in peripersonal/extrapersonal space	A VR evaluation tool highlights asymmetry in stimuli detection generally not detectable in normal subjects
	Rehabilitation	Holden et al 1999	The importance of observational learning	VR improves complex spatial learning and the possibility of generalize it
		Wann et al 2001	Binocular information in grasping rehabilitation	VR as interesting tool for grasping rehabil.
		Bertella et al. 2001	Topographical disorientation	VR for training in safety environments
		Myers and Bering, 2000	Neglect syndrome rehabilitation	VR system could better simulate eye-patching strategy in neglect recovery
		Weiss et al. 2003	Crossing street ability recovery in Neglect patients	VR enhances careful behaviours within everyday-like situations

memory abilities. Several researches assume that this problem may be overcome assessing memory functions in VR.

For example, in assessing prospective memory (remember to perform action in the future), Brooks and colleagues [21] had developed a VR system able to study cue-based, time-based and activity-based memory retrieval In order to do this they have developed a four-rooms VE, navigable on desktop modality. Patients were requested to remember and classify objects (cue-based task), to remember and use objects (activity-based task) and to remember in performing action in time (time-based task). From this experiment authors were able to conclude that, compared to standard tests, VR was an interesting tool for controlled assessment of prospective memory ability.

In studying incidental memory (the explicit memory of an event encoded without intention), Andrews and colleagues [22] compared memory performances in non-patient subject using both highly interactive and static VR interfaces. Furthermore authors stressed the importance of active negotiating action in VR contexts comparing memory performances of active users in VR with memory performances of a yoked passive observer. Results show how passive participants were more able to memorize events than active ones, which were attentive engaged in interacting with VR. These data could open an important discussion on active-passive dichotomy in object, events and spatial memorization that is actually ongoing. Even in is possible to have an attentive interference in memory process, several authors, in fact, stressed the importance of active participation in planning or execution of action as a fundamental factor for events learning and place memorization [23]. In a second experiment done by the authors, results appear discordant.

Even if passive observers were able to remember object position within an environment, active participants were more able to learn and memorize the entire environment; even if they were engaged in a goal-oriented task during the VR exploration.

If not explicitly requested to participants, spatial layout memory recall seems to be a very useful test for incidental memory in active participants.

In memory function recovery, VR was used both for restore function (repetitive memory exercises in order to improve performance in memory task), both for reorganize memory function (use intact function to aid damaged one). The first approach was generally considered as limited in recovery success and for this reason it was not largely used even with VR. In patients with dementia a PC-based virtual apartment was used in order to increase memory performances [24]. VR application appears to be an interesting tool to creating differentiates memory techniques and increasing patients' motivation.

In reorganizing memory function an "error-free" learning approach was used with amnesic patients. These patients in fact had generally lost the capacity of distinguish between correct and incorrect responses and show tendencies on use errors as cues for successive performances [25, 26]. Using a VR environment therapists were able to prevent and avoid patient's errors [27]. Furthermore, Glisky and colleagues [28] used a "vanishing cues" method in which they used a VR system to provide patients with information that could be reduced according with patient progresses. Using this method authors were able to teach amnesic patients in interacting with complex situations. The same author runs an important work in memory and motor remediation with severe amnesiac patients [29]. The study aims to investigate if patient with amnesia could already learn particular motor tasks.

If, for example, an amnesic patient is impaired in verbal memory function he/she generally could be preserved in motor task ability; but is he/she able to learn novel action task? In a VR based system authors investigated if these patients were able to trace a drawing while they are looking at their "mirrored" hand displayed on the screen, and not directly to their real hand. Results show how, even they are not aware in having performed this specific action before, amnesic people were able to learn and perform even complex motor actions.

How is easy to understand, virtual reality hold an important role in memory assessment and treatment. Moreover it seems to be able in facing with different cognitive impairment forms in which memory disorder could appear.

5. Plan and motor abilities VR applications

Even in motor planning and execution VR was largely adopted assuming diversified roles according with research and treatment goals. Avoiding in doing a long list of work that have included VR in their protocol, my specific goal in this chapter is on providing some examples of how is possible take advantage in using VR according with strategic objectives in rehabilitation.

A possible approach according to Wilson and colleagues [30], for example, should be in developing a VR tool in order to give patient action possibilities. This becomes possible avoiding physical limitations determined from patients' own disability. The system allows patients in actively construct and execute action within a simulated environment turning them able in interacting whit the environment through sensory channels different from impaired ones. This approach turns patients autonomous in their everyday environment increasing their motivation in performing actions.

According to another point of view Rose and colleagues [31] have developed a VR system able to substitute natural environmental stimulations with artificial stimuli derived from VR system. The aim of their work was in monitoring patient's reactions to specific categories of sensory stimuli and in assessing if patient's capacity of make relations among different kinds of stimulation was preserved. This VR use appears to be precious in residual capacities evaluation; in particular when pathology symptoms appear confused. Had hoc VR tools allow to provide patients with specific type of stimulation according with assessment goals. Moreover VR systems were able to monitor all patients' reactions to such kind of stimuli, in order to determine selective impaired functions. This approach requires innovative technology support and seems to be very difficult to conduct without computer-based systems; Especially because it turns very hard managing and monitoring several different variables contemporaneously. VR systems may allow this complex process on line or even in a post-hoc analysis.

The importance of haptic feedback was investigated in a controlled study [32]. A VR haptic device was used in order to test procedure for the qualitative assessment of motor coordination in post-acute stroke upper limb rehabilitation. Patients involved in this research are requested to make a coordination task such as reach, grasp and move a haptic device to different generated position on the screen. Movement device coordinates were monitored and also targets position, time, and trajectories distances were registered. Results show how, comparing velocity and accuracy, the VR system seems to be able to establish a test method for measurement of upper extremity functional motor skills between healthy individuals and stroke patients. Increasing the complexity of the task authors are satisfied the VR system will be able to lead in motor recovery. The haptic return possibility is an important focus area in VR-rehabilitation-system planning and development. Even if, with simple perceptive stimulation and feedback system, patients were able to derive enough information during motor exercise, haptic modality seems to provide an important added value in correct task execution within VR. Through haptic device VR tools become even more similar to "real" motor execution path. Moreover providing haptic tools during motor performance it is possible to increase sense of presence that seems to be necessary to a good and lasting learning.

Another possible approach to VR rehabilitation is on combining action simulation processes, such as imaginative exercises, with VR stimulation in order to enhance the

recovery of motor function in brain-injured hemiplegics patients [33]. This approach aims in develop egocentric and allocentric upper-limb motor imagery exercises that will be supported from VR multimodal stimulation and feedbacks. Through constructing their own personal image of the motor behaviour that has to be trained, patients were allowed in elaborate their own schema and sequences of movements. This will be possible by displaying highly stylized sketches of the motor behaviour on a computer screen and gradually increasing the perceptual realism of the visualization until optimal learning is achieved. Contrary to the "vanishing cue" technique explained in memory rehabilitation paragraph [34], in this approach VR does not "substitute" perceptual information by depicting all body imagine involved in movement, and decreasing it according to patient's progress; VR stimulation provided in this protocol should be something like perceptual or auditory action cue able to support active re-creation of movement paths. Inferring on actions schemas relations, actively reasoning about performance execution and contemporaneously being supported by VR multimodal stimulations, patients could individuate their own way to perform actions and learn to execute them in order to reach their goals. Furthermore user-centred portable VR systems could be provided allowing patients in continuing their rehabilitative training at home, according with progresses reached in controlled rehabilitative sessions.

An interesting research was recently run in order to assess if complex motor behaviours acquired in VR environment are transferable to similar not simulated environment [26]. The study implies that several cognitive domains, assessed in VR environment, should be associated with ability to face up with everyday activities and challenges. Within a VR kitchen, fifty-four right and left traumatic brain injured patients were involved in meal preparation tasks that implies multiple action steps. Different kinds of cues are provided when patients turn not able in continuing the task; several feedbacks are given them in order to enhance motor learning. The authors concluded that, with this VR system, there is a good reliability and concurrent validity for assessing patient with brain injury in complex motor tasks and also that VR is a good predictor of the same performances in a not simulated kitchen. According to this research is possible to emphasize once more how there could be a transfer of procedural knowledge from virtual to natural environment, supporting the importance of VR in everyday performances recovery training.

Finally, exploring rehabilitative VR applications in motor function recovery it will be possible to highlight how an interesting use of VR systems could be in enhancing feedback provided to patients. Giving them an "augmented feedback", in fact, Holden and Todorov [35] had developed a system able to detect patient's errors and return it to him with an overextended feedback signals, in order to cueing and correcting upper limb motor action. Action task was developed starting from target desired movement (such as putting and envelope into a mailbox slot) and not on specific motor skill (such as reaching, grasping and extending). In stroke patients a rehabilitative harm motion protocol through imitative learning was developed. Patients were requested to perform, in natural and VR environment, a goal oriented movement by imitating action displayed. Results show not only an improvement in virtual task performance but also a transfer of capacity in not simulated environment.

Finally it seems proper to say that according with its highly interactive proprieties, VR was largely used in motor rehabilitation but only selected example of possible application were provided here. This chapter goal, in fact, is in providing cues for assessment and rehabilitative application that could be developed and modified according with different clinical needs.

Furthermore among motor behaviour impairments I've not mentioned action deficits due from executive function damage that will be treated in the following paragraph.

6. Executive functions VR applications

The term "executive functions" is generally referred to a group of behavioural skills that includes [36]:

a) the ability of planning a sequence of actions,
b) the ability of maintaining attention in time,
c) the ability of avoiding the interfering stimuli and using the feedback provided by others,
d) the capability of coordinating more activities together at the same time,
e) the cognitive and behavioural flexibility and
f) the other abilities used to cope new situations and stimuli

Loss of executive functions is primarily a consequence of brain injury located in the prefrontal cortex area. As Damasio [37] pointed out, in everyday life patients may show great limits, decisional problems and inabilities connected with high levels of social inadequacy. In cognitive rehabilitation, traditional protocols are mainly centred to protect or recover the basic instrumental cognitive functions in a clinical or lab setting, but executive function cognitive rehabilitation should require particular attention in relation to their real-life behaviour consequences. According to Damasio it could be underlined four main failures of the laboratory situations to mimic reality: a) choices and decisions are only to be evoked, not to be really performed; b) there is a lack in the normal cascade of events as actions and reactions; c) temporal frame is generally compressed; d) situations are not really presented, but only described through language.

VR was specifically indicated to allow patients in recovering their planning, executing and controlling skills by implementing sequences of actions and complex behavioural patterns that are requested in everyday life [38, 39].

Moreover, both in the assessment and in rehabilitation of dysexecutive symptoms and frontal lobe syndrome, the employment of computer based tools and virtual environments seem to have another fundamental advantage with respect to traditional non-immersive means.

Regarding computer based applications used in the assessment of cognitive functions the Tower of London (TOL) Test [40] has been studied in order to obtain a touch-screen computerized version [41]. With this TOL computerized version there was the possibility to carry on a more detailed performance analysis obtained from the registration of patient movements. Moreover the Wisconsin Carding Sorting Test (WCST) [42] has been studied in order to obtain different computer-based versions [43, 44] such as the Bexley-Maudsley Category Sorting Test [45]. With these tests version it is possible to save time in the scoring step, to simplify all the procedures, to create and show new integrates multi-media scenarios more similar to reality than traditional approaches [46].

Following these assumptions the V-STORE application, depicted in Figure 2, uses a traditional protocol integrated with sessions of Virtual Reality [47].

V-STORE is a close environment within which patients have to reach objects and moving it from one recipient to another according to therapist verbal commands. In this case therapist can even introduce a series of distracting events, such as speed modification, in order to increase difficulty and generate time pressure.

For each trial, the system is able to record accuracy, execution time, movements and planning in subject performances in order to allow further analysis. Furthermore the managing steps taken to face distracters or difficulties encountered during the task, that often constitute the greatest limit for frontal patients could be monitored.

For each trial, the system is able to record accuracy, execution time, movements and

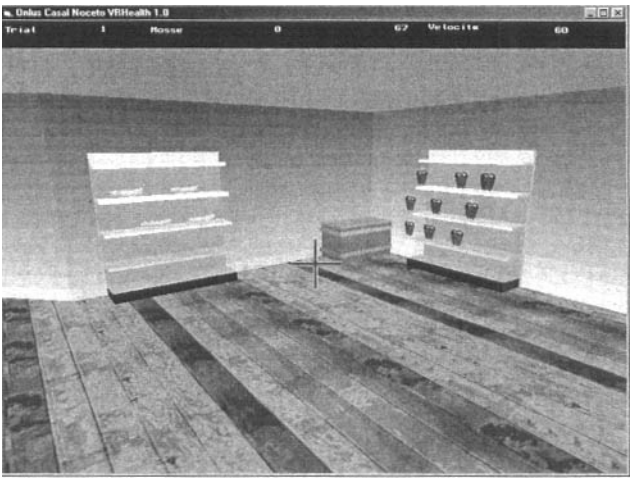

Figure 2. A screenshot of the first level of V-STORE

planning in subject performances in order to allow further analysis. Furthermore the managing steps taken to face distracters or difficulties encountered during the task, that often constitute the greatest limit for frontal patients could be monitored. A pilot study conducted in this environment has shown encouraging results on V-STORE applicability with pre-frontal patients.

Using a VR everyday-like environment it was possible to train patients' abilities in recognizing object and use it within a monitored situation. Further more V-STORE training approach, such as more VR application in rehabilitation, could enhance a playing aspect in function recovery.

7. Spatial Knowledge representation VR applications

Through their 3D graphical sort and their high interactivity possibilities, environments developed in VR were generally used especially for visuo-spatial assessment and treatment.

Among this intervention area, VR applications seem to be varied. VR, in fact, was applied on evaluation and treatment of spatial knowledge in general, topographical disorientation and visuo-attentive deficits such as neglect syndrome.

7.1 General spatial learning

In order to evaluate if a spatial learning is possible in VR simulated environments and if this learning was transferable to not simulated environments several studies were conducted [48, 49, and 50].

Firstly McGee and colleagues [51] ran a comparison between "paper and pencil" assessment tools and computer-based ones. VR interactive scenarios result to be effective in neuropsychological healthy subjects' spatial abilities assessment. A different VR use in neuropsychology was in evaluating the observational learning of spatial tasks in stroke patients [52]. This application aims in enhance recovery of explorative functions within a complex VE through imitation of action performed by the therapist in natural environment.

At the end of the training, patients were not only able to learn complex exploration behaviour but also to generalize this knowledge to not simulated contexts.

Another VR rehabilitative approach was analyzing the binocular information role in visual amnesic patients involved in a grasping task within a virtual environment [53]. Object depicted in VE could vary in shape, dimension and movement velocity. Furthermore it could be possible to change depth indexes through which it turns possible visualize object in VR. This work allows highlighting how using VR systems is possible to obtain interactive simulation hardly obtainable in natural environments or in laboratory settings.

Finally a research on egocentric/ allocentric memory brain correlates was run using VR environments [54]. Anoxing hyppocampal damaged patients were tested in memory tasks within a VE and f MRI study was conducted. According with O'Keef and Nadel study [55] hyppocampal activation was registered only in allocentric memory task. VR gave in this case the opportunity of combining egocentric and allocentric spatial memory tasks in the same experimental session allowing fMRI observation without artefacts

7.2 Spatial disorientation

Several studies were conducted in order to investigate if VR could be an interesting tool to recover spatial disorientation skills in children who were impaired in mobility by their physical disabilities. In particular they want investigate if a complex spatial performance acquired in VR may be transfer to the same not simulated environment, increasing spatial mobility in disabled people [56]. These studies highlight improvement of spatial abilities in natural environment in patients who had rehabilitative session in VR and stresses the importance of assess memory in VR environments in order to create ecologically situation that are not possible with other assessment forms.

In order to evaluate and recover patients with topographical disorientation a VR based environment was developed [57]. Both patients with topographical agnosia (the incapacity in recognizing places) and topographical amnesia (the incapacity in remember position places) were repetitively immersed in suited VR. The peculiarity in this VR approach is on training disabled patient within a safety environment leaving them to be actively free in exploration.

Finally in Alzheimer disease VR-based rehabilitation seems to give new possibilities in recover orientation functions if linked with auditory devices that could add integrated feedbacks on perceptive experience [58].

7.3 Neglect

Among spatial knowledge representation an important impairment was represented by unilateral spatial neglect syndrome. Persons with right hemisphere stroke are particularly vulnerable to visuo-attentive deficit of the left side of space. After stroke on the right side, not only is detail less readily perceived in the part of space opposite to the lesion site, but in some cases global perception overall is disrupted.

The introduction of VR application in research on neglect syndrome had developed a large range of application areas. Maringelli and colleagues [59], for example, studied egocentric/allocentric based attention orientation using VR tools. Using VR it was possible to authors provide or not provide participants with a body simulation in VE and evaluate if they were able in pay attention on stimulation provided in peripersonal or extrapersonal space.

Results shows how participants were able to detect proximal stimulus when their body was provided in VR and how data are opposite when body was not provided. This kind of asymmetry, optimally derived from VR simulation, results to be present in patient with neglect and not generally evident in normal subjects.

In neglect rehabilitation, VR was firstly used combined with traditional rehabilitative approach stressing how this kind of combination could improve visuo-attentive function

recovery [60].

Rehabilitative protocols that used only VR approach were generally focused on the possibility of track patient's position, and tried to "anchor" attention to neglected spatial area.

According to this approach Myers and Bering [61] developed a VE and presented to patient with a left visual distortion. Some object presented within the environment moved from right to left in order to lead patients in direct attention towards this environment side.

Simultaneously a dark area was presented on 30% right environment area (such as eye patching strategy in natural environment). If patient was able to rotate his head on the left side the dark area decreases until disappear forcing patients in directing attention on the neglected area. Even results appeared not clear this VR application shows the potentiality of interactive scenarios in rehabilitation.

Another important VR use in neglect rehabilitation is on everyday patients' activities [62]. A safety training VR environment was developed in order to teach patients in crossing streets in a safety manner. Multimodal feedbacks were provided in order to enhance careful behaviours in everyday-like situations. Patients becomes progressively able in manage complex activities not only in VR but also in a real street.

In conclusion it is possible to state how a specific rehabilitative intervention area such as neglect syndrome, and also in general spatial representation, VR stimulation thanks to its high interactivity property may constitute an usable and safety tool for everyday functions recovery.

8. Conclusion

How is possible to note, nowadays VR introduction in neuropsychology seems to be wide and largely consolidated. Among cognitive function evaluation and treatment VR systems application are several, moreover VR approaches in specific cognitive function recovery appear differentiate. This contribution had the intention of point out if it was possible to use VR in cognitive neuropsychology, and also how was the use of this innovative approach in evaluation and rehabilitation of cognition.

As I have pointed out in this chapter, within a VR environment the complexity of stimulus challenges found in naturalistic settings could be delivered while maintaining the experimental control required for rigorous scientific analysis. These results could have greater clinical relevance and direct implications for the development of more effective rehabilitation approaches. Moreover VR systems can provide repeated learning trials and offer the capacity to gradually increase the complexity of tasks while decreasing the support—feedback provided by the therapist. Finally VR can help to address rehabilitative goals by allowing the development of low-cost training environments eventually consistent with the client's home environment.

Lastly I would clarify how it turns important that neuro-rehabilitation works through, not only a passive repetition of behaviours that have to be recovered, but also on active involvement of patients in planning and execution of behaviours. According to this, VR could be considered as a new medium defined in terms of its effect on evaluation and treatment of brain dysfunction within cognitive neuropsychology approach. Patients involved in an active interaction with VR, in fact, were able to create different mental models in order to understand and learn how to correctly perform or recover correct behaviours. VR systems developed according to these objectives could be even graphically simple environments (even 2-dimesional ones) but have to allow a large range of patient's interaction possibilities. Objects included in a virtual environment have to be partially or totally modified through an active "virtual manipulation" and interaction with the environment have to provide them *affordances* [63] for new action choice. In a cognitive

neuropsychology approach evaluative and rehabilitative protocol linked with VR should have to make patients able to create new personalized and self-made cognitive strategies in order to improve their independence also to unfamiliar environments. Interacting with VR patients should be able in creating representation of actions and in consolidating representation generalizing learning event to not simulated environments.

The new challenge in cognitive neuropsychology application approach have to be not only in creating a versatile and engaging tool, able to substitute the classical ones, but also on support the growth of a focal instrument. Innovative VR-based applications would be able to ideate a rehabilitative setting customized on specific patient's need and would allow to project a rehabilitation that can be modified according to patient's achievement.

Supporting an active self-creation of representative learning strategies, the interaction between patient and VR may enhance the creation of autonomy processes and helps the generalization of learning. More than a playing tool supporting cognitive or motor performances VR simulation has to provide a powerful chance to build personal meaning, map and strategies interacting with it. The possibility of modifying the environment interacting with it will help patients finding themselves new cues for behaviours.

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SECTION II

CYBERTHERAPY EXPERIENCES: CLINICAL TRIALS IN THE TREATMENT OF MENTAL DISORDERS

The recent growth of technology in the mental health field is a reflection of the continuous advances and discoveries of hundreds of investigators who use virtual reality and other simulation and advanced technologies to help patients with both mental and physical disorders. Over the past five years an increasing number of professional publications have high lighted clinical applications of virtual reality in the assessment and treatment of anxiety disorders, eating disorders, and sexual dysfunction as well as in neuropsychiatric and neuropsychological assessment and training, with particular adjunctive applications in the fields of physical therapy, training, and rehabilitation. Further applications have included distraction from unpleasant or painful medical procedures and treatment for posttraumatic stress disorder. A wide variety of other fascinating concepts and applications are ongoing.

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5 The use of VR in the treatment of panic disorders and agoraphobia

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Abstract Panic disorder with agoraphobia (PDA) is considered an important public health problem [1-3]. The efficacy of cognitive-behavioral therapy (CBT) for PDA has been widely demonstrated [4, 5]. The American National Institute of Health [6] recommended Cognitive-Behavioral programs as the treatment of choice for this disorder. This institution also recommended that researchers develop treatments whose mode of delivery increases the availability of these programs. Virtual Reality based treatments can help to achieve this goal. VR has several advantages compared with conventional techniques. One of the essential components to treat these disorders is exposure. In VR the therapist can control the feared situations at will and with a high degree of safety for the patient, as it is easier to grade the feared situations. Another advantage is that VR is more confidential because treatment takes place in the therapist's office. It is also less time consuming as it takes place in the therapist's office. Considering the wide number of situations and activities that agoraphobic patients use to avoid, VR can save time and money significantly. Another advantage in treating PDA using VR is the possibility of doing VR interoceptive. VR could be a more natural setting for interoceptive exposure than the consultation room because we can elicit bodily sensations while the patient is immerse in VR agoraphobic situations. Finally, we think that VR exposure can be a useful intermediate step for those patients who refuse in vivo exposure because the idea of facing the real agoraphobic situations is too aversive for them.
In this chapter we offer the work done by our research team at the VEPSY-UPDATED project. We describe the VR program we have developed for the treatment of PDA and we summarize the efficacy and effectiveness data of a study where we compare a cognitive-behavioral program including VR for the exposure component with a standard cognitive-behavioral program including in vivo exposure and with a waiting list control condition. Our findings support the efficacy and effectiveness of VR for the treatment of PDA.

1. Introduction

The essential feature of Panic Disorder is the experience of unexpected and recurrent panic attacks. A panic attack is a discrete and sudden episode of intense fear with several anxiety

symptoms (dyspnea, dizziness, palpitations, trembling, sweating, nausea, dizziness, fear of dying or losing control, etc). Many people who have panic attacks also avoid situations that they associate to panic (situations in which escape might be difficult or help not available, as being in a crowd, traveling in a bus or train, standing in line or staying at home alone).

This avoidance behavior is called Agoraphobia [7, 8].

Panic disorder with agoraphobia (PDA) is today considered to be an important public health problem [1-3]. The efficacy of cognitive-behavioral therapy (CBT) for panic disorder and agoraphobia has been widely demonstrated [4, 5]. The American National Institute of Health [6] recommended Cognitive-Behavioral programs as the treatment of choice for this disorder. This institution also recommended that researchers develop treatments whose mode of delivery increases the availability of these programs. From this perspective, it is also possible to understand the increasing insistence on considering two axes to test psychological programs: the efficacy Axis, or axis of internal validity, and the effectiveness, or clinical utility Axis [9].

With respect to Axis I, at the present time we have at our disposal treatment programs that are supported by well designed empirical studies. However, there is still a long way to go before these programs can be recommended as a standard alternative that could reach a high number of panic sufferers. That is, it is important to progress in the Axis II or clinical utility of CBT programs for PDA. Virtual Reality and telepsychology based treatments can help to achieve this goal. VR has several advantages compared with conventional techniques.

In this chapter we offer the work done by our research team at the VEPSY-UPDATED project. The aim of the following sections is, on one hand, to describe the clinical protocols and the prototypes of the Virtual Reality designed by our group at Jaume I University, Valencia University and Politechnic University of Valencia to assist the exposure component of a cognitive-behavioral program for treating panic disorder with agoraphobia (PDA). On the other hand, we have conducted a large-scale clinical trial to obtain data about the efficacy and effectiveness of VR exposure vs. In vivo exposure in the treatment of PDA. We summarize the efficacy and effectiveness data of that study where we compare a cognitive-behavioral program including VR for the exposure component with a standard cognitive-behavioral program including in vivo exposure and with a waiting list control condition. Our findings support the efficacy and effectiveness of VR for the treatment of PDA. We finish this chapter discussing our results and pointing at several future directions.

2. Treatment of panic disorder and agoraphobia

2.1 Traditional treatment of panic disorder and agoraphobia

As we have already mentioned, the effectiveness of cognitive-behavioral therapy for panic disorder and agoraphobia has been widely demonstrated [4, 5]. These interventions have shown higher effectiveness that waiting-list, supportive therapy, relaxation, and placebo control [10]. These programs offer the highest effectiveness and the lowest drop-out rates compared to pharmacotherapy and combined treatments [11]. The American National Institute of Health [6] recommended Cognitive-Behavioral programs as the treatment of choice for this disorder. This institution also recommended that researchers develop treatments whose mode of delivery increases the availability of these programs. From this perspective, it is also possible to understand the increasing insistence on considering the two aspects that are taken into consideration in the clinical guide (*Template for Developing*

Guidelines: Interventions for Mental Disorders and Psychosocial Aspects of Physical Disorders) that has been developed by the committee of experts of the *American Psychological Association* within the framework for "empirically valid treatments or treatments based on evidence" [9]. This guide recommends to take into account two "Axes": the efficacy Axis, or axis of internal validity, which entails analyzing the scientific evidence that is available for any given intervention, and the effectiveness, or clinical utility Axis, which entails analyzing the possibility of the intervention in the specific context in which it has to be offered [12, 13]. In the opinion of the group that developed the guide, all this indicates to what degree the intervention will be useful in the clinical situation in which it is going to be applied, i.e. it means taking into account among other factors: the generalizability of the administration of the the intervention in a variety of contexts; the feasibility of the intervention through patients and contexts, and the cost and benefits associated with the administration of the intervention [4].

With respect to Axis I of the clinical guide, at the present time we have at our disposal treatment programs for PD, with or without agoraphobia, supported by empirical studies of exceptional methodological rigor. The "well-established" treatments that have so far shown themselves to be the most effective up until now are the treatment for the control of panic developed by the Barlow group [14-16] and the cognitive therapy developed by the Clark group [17, 18]. In both cases, we are dealing with very clear and structured manualised treatments [4]. As far as the efforts that have been carried out so far in respect to Axis II, there is already evidence about the utility of the brief programs supported by self-help materials in the treatment of PD [19-21]. There is still a long way to go, however, before these programs can be recommended as a standard alternative that could substitute existing programs [4]. Other aspects of Axis II have begun to be studied, such as for example the feasibility of the treatment (e.g. ease of dissemination) or generalizability (degree to which its application is backed up in clinical practice). A study carried out by Wade, Treat & Stuart [22] demonstrated that cognitive-behavioral programs designed in controlled studies were transportable to a public mental health care population. These results were maintained in a one-year follow-up [23]. Our research team has obtained similar results in a recent study [24].

The treatment of PDA has improved dramatically in the last years. However, researchers have to continue studying ways of application of cognitive-behavioral programs that consider cost-benefit issues as availability, feasibility and ease of application. Virtual Reality based treatments for PDA can help to achieve this goal.

2.2. Virtual reality treatment for panic disorder and agoraphobia

Virtual Reality is a new technology that has great potential for Clinical and Health Psychology as it provides alternatives for assessment, treatment, training, and research, which are not available using conventional psychological methods.

Regarding PDA, VR has several advantages compared with conventional techniques to treat this disorder. One of the essential components to treat these disorders is exposure. Traditionally, exposure is carrying out in vivo or using imagery. In in-vivo exposure patients undergo graded exposure to what they fear most with the help of a psychologist. In comparison with this type of technique, in VR the therapist can control the feared situations at will and with a high degree of safety for the patient, as it is easier to grade the feared situations. Another advantage is that VR is more confidential because treatment takes place in the therapist's office, and patients need not fear to be exposed in public or simply that their problem might be known. Besides, it is much cheaper as it takes place in the therapist's office, and considering the wide number of situations and activities

that agoraphobic patients use to avoid, VR can save time and money significantly. In imaging exposure, psychologists train patients to cope with what they fear using imagination techniques, asking patients to imagine as exactly as possible that what they fear is happening. Compared to this technique VR is more immersive because it stimulates several sensory modalities (audio, visual, and vestibular). This can be of great help to people who have difficulties imagining scenes. The therapist also knows what the patient is seeing at all times and can therefore know more easily and accurately which stimulus is provoking the fear response.

Another advantage in treating PDA using VR is the possibility of doing VR interoceptive exposure at the same time of conducting situational exposure. Interoceptive exposure consists of exposing patients to bodily sensations similar to the ones experienced in their panic attacks. This can be achieved carrying out several tasks in the consultation room, such as blowing through a straw, hyperventilate, running, etc. We think that VR could be a more natural setting for interoceptive exposure than the consultation room because we can elicit bodily sensations while the patient is immerse in VR agoraphobic situations.

Finally, we think that VR exposure can be a useful intermediate step for those patients who refuse in vivo exposure because the idea of facing the real agoraphobic situations is too aversive for them. We think that making those patients go through a VR exposure treatment can increase the likelihood that they accept an in vivo exposure program afterwards.

All this advantages has guide our work regarding the design and testing of a VR exposure program for treating PDA.

There are already some studies about the use of VR and panic disorder/agoraphobia.

Jang, Ku, Shin, Choi & Kim [25] informed that most of the patients had difficulties to become immerse in the VR environment. Vincelli, Choi, Molinari, Wiederhold & Riva, [26] described a VR treatment protocol for PDA, but they did not offer efficacy data. Finally, Moore, Wiederhold, Wiederhold & Riva [27] presented VR environments that activated arousal in a subclinical sample but they did not offer efficacy data.

3. The clinical protocols

3.1. Assessment protocol

The assessment protocol was designed following the guidelines of the National Institutes of Health Consensus Development Conference on the Treatment of Panic Disorder held in October 1992 and reported in Shear and Maser [28]. The objective of this conference was to develop a standard assessment package for Panic Disorder (PD). The main topics in PD assessment are: a) Structured diagnostic assessment; b) Panic attacks and limited symptom episodes; c) Anticipatory anxiety; d) Phobic symptoms; e) Overall functioning, global severity and improvement; f) Comorbidity and coexisting symptoms.

Besides the topics recommended by these authors, we have included new topics that a recent review of the scientific literature about panic and agoraphobia has revealed. These new topics are related with the axis II or clinical utility axis of the clinical guide (*Template for Developing Guidelines: Interventions for Mental Disorders and Psychosocial Aspects of Physical Disorders*) that has been developed by the committee of experts of the *American Psychological Association* within the framework for "empirically valid treatments or treatments based on evidence" [9]. The more important topic that we have included is the satisfaction and acceptance of the treatment program.

In the next section we describe the assessment protocol we have designed.

3.1.1. Diagnostic instruments

The instruments used to establish the diagnosis are the following:

Screening Interview: This instrument, developed by our group, screens information about demographic variables, reasons for seeking treatment, duration of the disorder, perceived severity, past treatments, alcohol and substance intake, and presence of physical illness. The instrument also screens the occurrence of possible anxiety disorders.

Consent Form: Patients will read and sign an informed consent form about the study before starting the assessment phase.

Medication control: During the study, the patient cannot increase the medication dosage. However the patient can start taping medication when he/she feels better with the guide of a psychiatrist. This is an index of improvement that should be recorded using this instrument. The therapist has a record of the type and dosage of medication throughout all the process.

Diagnostic Interview (ADIS-IV-L) [29]: It is a semi-structured interview that assesses the DSM-IV anxiety disorders and mood disorders and screens for other major disorders. We will use the sections for PD and AG.

Agoraphobic Avoidance and Fear Scale: Adapted from Mark and Mathews [30]. The patient and the therapist establish 4 behaviors or situations that the patient avoids because of panic and agoraphobia. He rates the level of avoidance in a 0-10 scale where 0 = *I never avoid it* and 10 = *I always avoid it*; and the level of fear in another 0-10 scale, where 0 = *No fear* and 10 = *Extreme fear*.

Degree of Belief in Catastrophic Thoughts: The main catastrophic thoughts related to panic attacks in target behaviors or situations are specified. The degree of belief in those thoughts is assessed in a scale ranged from 0% to 100%: when 0% means that the patient does not believe the thought at all, and 100% means that the patient believes that the thought is totally true.

Inclusion and exclusionary criteria: To take part in the study, patients should meet DSM-IV diagnostic criteria for panic disorder (with or without agoraphobia) or for agoraphobia (with or without PD history). The exclusionary criteria are severe major depression or psychosis, current alcohol or drug dependence, and severe physical illness.

Panic attack record: Following Shear and Masser's recommendations [28], we have elaborated a panic diary, which tries to collect the maximum information on the patient's panic attacks. Daily, the patient records the following variables related to his/her panic attacks: situation, duration, whether it has been a panic attack or a high anxiety episode, whether it has been an unexpected panic attack or a conditioned one, what symptoms have appeared and their intensity, anticipatory anxiety, and severity of the attack.

3.1.2. Self-report measures

Our assessment protocol includes several self-reported measures which assess different clinical areas: a) measures directly related with panic disorder and agoraphobia; b) Measures related with general psychopathology (depression, anxiety and general symptoms); c) A self-report that measures functional impairment. The self-report instruments are the following:

Panic Disorder Severity Scale [31]: It is a clinician rated composite symptom scale for panic disorder. This scale includes ratings of frequency and distress of panic and

panic-like sensations (limited symptom episodes), severity of anticipatory anxiety, severity of situational avoidance, severity of impairment or interference in work and in social situations. In addition, there is one item rating phobic avoidance of physical sensations. Means for a PD sample (with mild or no agoraphobia) are 1.59 (SD= 0.43), for total scale, 1.83 (SD= 0.82) for frequency, 2.19 (SD= 0.61) for distress of panic, 1.94 (0.75) for anticipatory anxiety, 1.23 (SD= 0.65) for situational avoidance, 1.08 (SD= 0.58) for interoceptive avoidance, 1.29 (SD= 0.98) for work impairment, and 1.55 (SD= 0.82) for social impairment.

Anxiety Sensitivity Index [32]: It is a 16-item questionnaire that measures fear of anxiety. Each item expresses a concern about a possible aversive consequence of symptoms associated to anxiety. Items are rated on a 5-point scale. Means in a PD (with mild or no agoraphobia) was 32.1 (SD= 11.3) [33]. For nonclinical samples the mean score was 19.1 (SD= 9.11) [34].

The Mobility Inventory for Agoraphobia [35]: It is a 27-item questionnaire rated on a 5-point scale to assess agoraphobic avoidance behavior. The questionnaire evaluates the severity of the patient's avoidance, both when alone and when accompanied. Means for a PDA sample are 3.30 (SD= 0.99) when alone, and 2.41 (SD= 0.70) when accompanied, whereas for a normal control sample, means were 1.25 (SD= 0.24) and 1.07 (SD= 0.08) for alone and accompanied respectively.

Beck Depression Inventory [36]: This is one of the most widely used inventories for evaluating the presence of depressive symptoms. It is a 21-item self-report questionnaire. Scores of 10 or less are considered normative.

State-Trait Anxiety Inventory [37]: In this study only the 20-item Trait Anxiety Scale was used. The Anxiety Trait is defined as a relatively stable anxiety apprehension by which participants differ in their tendency to perceive situations as threatening and to increase, consequently, their state of anxiety. The scale has 20 items, half of them formulated in a positive way and the other half in a negative way. The score is shown on a four-point intensity scale. Oei, Evans & Crook [38] reports that the STAI-T in a PDA sample ranges from 51 to 54 and for those with PD ranges from 44 to 46.

Fear Questionnaire [30]: The FQ is a 24-item self-report measure that was designed specifically to monitor change in patients with phobias. Contains three five-item subscales (*agoraphobia, blood/injury,* and *social phobia)* a *global distress index* and a 5-item *anxiety/depression scale.* Means for a phobic sample are 47 (SD= 19.3) for the total phobia score, 17 (SD= 10.0) for agoraphobia, 15 (SD= 10.7) for blood/injury, 15 (SD= 8.5) for social phobia, 22 (SD= 9.1) for anxiety/depression, and 5.5 (SD= 2.7) for global phobic rating.

Maladjustment Scale [39]: This instrument assesses the degree of maladjustment the disorder causes in several areas of the participant's life. It consists in a 6-items scale rated from 0 to 5 where 0 = *Nothing* and 10 = *Very Much.* Means for a clinical sample is 18.04 (SD= 6.26), and for a normal sample 2.22 (SD= 1.66).

3.1.3. Specific measures to evaluate therapeutic effectiveness

We consider, in line with other researchers [40], that the following variables are important to determine the clinical significance of outcome in treatment effectiveness studies. These measures are related with the axis two or clinical utility axis of the clinical guide (*Template for Developing Guidelines: Interventions for Mental Disorders and Psychosocial Aspects of Physical Disorders*) that has been developed by the committee of experts of the *American Psychological Association* within the framework for "empirically valid treatments or treatments based on evidence" [9].

Therapist Global Impression: The therapist answers the question: *Considering your clinical experience, how do you evaluate the global severity of this patient?*, and evaluates from a clinical point of view the global impression about the patient's severity in a 1-6 subjective scale, where 1 = *Normal*, 2 = *Lightly disturbed*, 3 = *Moderately disturbed*, 4 = *Quite disturbed*, 5 = *Severely disturbed*, and 6 = *Very severely disturbed*. Adapted from Guy [41].

Expectations about exposure (EE): We have elaborated a questionnaire adapted from Borkovec and Nau [42] to measure the expectations about the virtual exposure treatment before starting it. The questions are about how logic the treatment is, to what extend it could satisfy the patient, if the patient would recommend this treatment to other people, if it could be useful to treat other problems, the usefulness for the patient's problem, and to what extend it could be aversive

Satisfaction with the exposure treatment (Se): We have also designed a questionnaire to assess the satisfaction with the exposure component. It screens the same aspects that the former questionnaire, but in this case it is fulfilled after the treatment completion. Adapted from Borkovec and Nau [42].

3.1.4. Assessment procedure

We established four assessment periods in order to test the efficacy and effectiveness of our treatment program: Pre-treatment assessment, post-treatment assessment after the completion of the treatment, and follow-up assessment, three and nine months after the completion of the treatment.

The pre-treatment assessment lasts two sessions summarized in table 1.

The post-treatment and follow-up assessment includes all the instruments, but the diagnostic interviews (screening and ADIS-IV).

3.2. Treatment protocol

3.2.1. Cognitive-Behavioral program for panic disorder

The program is a Cognitive behavioral program adapted from the most effective programs that are available [14, 17]. The treatment program include several components: a) Educational; b) Slow breathing training; c) Cognitive Therapy; d) Exposure; e) Relapse prevention. The treatment program includes nine sessions. The patients receive one session

Table 1. Assessment procedure

1ST SESSION (*video recorded for blind assessment*)
ADIS-IV. Consent form. *Homework:* Panic Attack Record, self-report questionnaires.
2ND SESSION
Collect and review self-report questionnaires. Target Behaviors: Fear, avoidance and belief in catastrophic thoughts. *Homework:* Panic Attack Record.
BLIND CLINICAL JUDGEMENT
Videotapes and assessment instruments will be given to an independent expert clinician who will make a clinical judgment.

per week for all components but exposure. The exposure sessions are carried out twice a week. The duration of the sessions is around one hour. The sessions are highly structured.

At the beginning of each session, the therapist presents the agenda with the contents that are going to be developed during the session. Due to the active role of patients throughout treatment, they can suggest the inclusion of additional topics related to panic in the agenda. All sessions finish with the assignment of homework. In the following paragraphs we describe briefly the treatment components.

EDUCATIONAL COMPONENT:

The main goal for the first session is to inform the patient about anxiety, fear, and panic.

The points to cover in the educational component are the following: a) The nature of anxiety, fear, and panic; b) Survival value of fear and anxiety; c) Anxiety and panic reactions are not dangerous; d) Three components of anxiety: physiological, cognitive, and behavioral; e) Important role of the cognitive component of anxiety; f) Cognitive model of panic; g) Treatment rationale.

SLOW BREATHING TRAINING:

We use one technique to treat the physiological component of panic and anxiety: breathing training. The points to cover in the introduction of this component are the following: a) Behavioral experiment: hyperventilation test; b) Role of hyperventilation in the development of a panic attack; c) Breathing training: Audio taped slow breathing rhythm (8-12 breathings per minute). Patient practices slow breathing training at the consultation room and as homework assignment. The goal is that the patient uses this technique to control the anxiety symptoms.

COGNITIVE THERAPY COMPONENT:

The goal of this component is to treat the cognitive component of panic disorder/agoraphobia. This component is introduced in the second session and practice along all the treatment. The content of this component is the following: a) Cognitive model of panic: From the cognitive model of panic, the important role of misinterpretation of bodily sensations is highlighted; b) Cognitive restructuring: Convenience of changing these misinterpretations to overcome panic attacks. The patient is trained in several cognitive restructuring techniques: Examining the evidence, challenging catastrophic thinking, rational self-statements, perspective taking.

EXPOSURE COMPONENT:

The main component of this treatment program is exposure. The main goal is to treat the behavioral component of panic disorder and agoraphobia.

The application of exposure was different in our study to test the efficacy of VR for the treatment of PDA. In our work we established two treatment conditions: Virtual Reality Exposure and In Vivo Exposure.

The main points to treat in the introduction of this component are: a) Advantages and disadvantages of avoidance; b) Exposure: definition and advantages; c) exposure rules; d) situational and interoceptive exposure; e) revision of target behaviors and planning of exposure sessions.This introduction is the same for the two different treatment conditions.

However, exposure is in VR in one of the treatment conditions and In Vivo in the other.

We carry out six exposure sessions without self-exposure instructions (VR *vs.* In Vivo) to control that the participants in the VR condition do not practice in vivo exposure at home. One way to control it is conducting two or more exposure sessions per week.

RELAPSE PREVENTION COMPONENT:

The main goal of this last component is to prevent future relapses once the treatment has finished. This component is carried out along the last session. The content of this component includes: Evaluation of the patient's improvement; review of the treatment components; improvement attribution to the different components; reinforcement to the patient's effort and achievements; evaluation of the belief in catastrophic thoughts; evaluation of fear/avoidance regarding target behaviors; expectations regarding panic attacks; need to generalize the learned skills to new sensations and situations; need to practice the learned skills; final evaluation of the treatment; setting of the post-treatment, and follow-up assessment meetings.

3.2.2. Step-by-step application of the treatment program

In this section we present the content of each treatment session, summarized in tables 2 to 8.

Table 2. Session 1 Schedule: Educational component

• What is anxiety?
• Adaptive value of anxiety.
• Absence of harmful consequences of anxiety.
• Anxiety responses (Threefold Response System).
• Central role of thoughts in the triggering of anxiety.
• Cognitive model of panic attacks.
• Hyperventilation test.
• Role of hyperventilation in panic attacks.
• Homework assignment: recording the catastrophic interpretations taking place along the week during panic attacks, and the degree of conviction.

Table 3. Session 2 Schedule: Slow breathing training and cognitive therapy

• Solving patient's doubts on the cognitive model of panic disorder and the role of hyperventilation in the crises.
• How to broke down the vicious circle of panic.
• Slow breathing training (seated or lying down).
• Introducing cognitive therapy.
• Cognitive discussion of any of the catastrophic interpretations of the most frequent bodily sensations during the crises.
• Homework assignment: practicing slow breathing (twice a day for half an hour each).

Table 4. Session 3 Schedule: Exposure to internal and external stimuli:

IN VIVO TREATMENT CONDITION
• Revision of some of the avoided sensations or situations. Disadvantages of avoidance.
• Introduction of exposure: definition and advantages.
• Rules to perform exposure
• Review of target-behaviors and design of a hierarchy
• Example of exposure task to a feared situation or sensation

Table 5. Session 3 Schedule: Exposure to internal and external stimuli:

VR TREATMENT CONDITION
• Revision of some of the avoided sensations or situations. Disadvantages of avoidance.
• Introduction of exposure: definition and advantages.
• Rules to perform exposure.
• Review of target-behaviors and design of a hierarchy.
• Training in VR.
• Example of exposure task to a feared situation and/or sensation using virtual reality.

Table 6. Sessions 4 to 8 Schedule for IN VIVO TREATMENT CONDITION:
Exposure to internal and external stimuli, and cognitive discussion without self-exposure instructions

• Revision of exposure hierarchies and of cognitive restructuring.
• In-session exercises of exposure to internal sensations.
• In-session tasks of In Vivo exposure to external stimuli.
• Cognitive discussions of catastrophic interpretations.
• Homework assignment: Panic Record. No self-exposure instructions.

Table 7. Sessions 4 to 8 schedule for VR TREATMENT CONDITION:
Exposure to internal and external stimuli, and cognitive discussion without self-exposure instructions

• Revision of exposure hierarchies and of cognitive restructuring.
• In-session exercises of exposure to internal sensations and external stimuli (at the same time) using VR.
• Cognitive discussions of catastrophic interpretations.
• Homework assignment: Panic Record. No self-exposure instructions.

Table 8. Session 9 Schedule: Relapse prevention

• Appraisal of the patient's evolution along therapy.
• Review of the content of the past sessions.
• Examination of the patient's attribution for improvement.
• Reinforcement on the therapist's part.
• Assessment of the residual belief in the catastrophic interpretations of bodily sensations.
• Assessment of the residual degree of fear and avoidance of particular situations and sensations.
• Examination of the patient's expectations regarding having future crises.
• Stressing of the convenience of continuous practice to generalize what has been learned in therapy to other bodily sensations, different to the habitual ones, which could appear in future panic attacks.
• Convenience of continuing practicing the techniques learned.
• Final appraisal of therapy.
• Setting the post-test and follow-up sessions.

4. The use of virtual reality in the clinical protocols

4.1. Technical characteristics of virtual environments

The VEPSY Virtual Environments (VE) have been developed with Virtools Dev 2.0. The devices used are a PC. The features required are: Pentium II or equivalent, 64 MB of RAM, CD-ROM drive, a monitor capable of displaying 1024 by 768 in 16 bit color (65536 color / Hi-Color), a Direct3D or OpenGL compatible 3D Graphic Accelerator Card with 8 MB of

RAM, a Pointing Device (Mouse, etc.), and a Sound Card. The software required is Microsoft Windows (95, 98, ME, 2000 or NT 4.0 (with Service Pack 6), Microsoft Internet Explorer 4.0 or higher, and Microsoft DirectX 5.0 or higher for DirectX compatible 3D Graphic Accelerator Cards. As for the visual devices we use a V6 (*Virtual Research*) HMD (Head Mounted Display) as the patient visual device, and a 17" Monitor as the therapist visual device. The Navigation & Interaction Devices are a mouse (2 Buttons) as the patient navigation & interaction device, and a Keyboard as the tharapist interaction device. The Audio Devices are the V6 Headphones as the patient audio device, and Headphones as the therapist audio devices.

Our VR program is called Panic-Agoraphobia. It has four Virtual Environments. In each virtual scenario exposure to external and internal stimuli can be carried out simultaneously. We can simulate several bodily sensations: heart palpitations, short of breath, blurred vision and tunnel vision. Also, in each scenario we can use several modulators to graduate the difficulty of the situation (number of people, threatening conversations, length of the trips, etc.).

The first scenario is a training room. This is the starting situation in which the patient will find himself/herself when he/she enters the scenario. Basically, the user must practice three things: a) *Movement within the Virtual Environment, b) Detection of Interactive Objects, c) Interaction with objects.*

Scenario 2 "The Room": This scenario is an environment of anticipatory anxiety where the user finds him/herself in a typical living room. In this room, it is possible to interact with the following objects:

Music player: The music player can be turned on or off (depending of the current status). When turned on, several commercial announcements can be heard about the starting of big sales in a mall.

Answering Machine: The answering machine is an interactive object which can be used with the left button (*one click*) of the mouse, capable of reproducing up to four different messages. Each of them presents a demand to shop certain objects, with different degrees of difficulty. When the activity at the room has finished, it's possible to go outside.

Scenario 3 "The Subway": In the starting situation the patient finds him/herself in a subway station, where a group of passengers is waiting for the arrival of the subway.

When the patient moves towards the edge of the platform and the psychologist presses a key, the subway arrives. At this point, it is possible to select the number of passengers coming inside the subway. Then, the patient must climb on the subway through any of its doors. Once inside, the psychologist may select if he/she desires any other passenger to climb on the subway. Once inside the subway, the psychologist may start the machine. The duration of the trip between the two stations is unlimited, and will only end if at the psychologist will. In this virtual environment, the psychologist can bring about the Heart Rhythm and Breathing Sound effect. This effect will play a sound that will simulate the patient's heart rhythm and breathing. This sound will have three levels that will represent several frequencies: Paused, Middle and Accelerated.

Scenario 4: "The Shopping Mall": This scenario is an environment that re-creates a Shopping Mall. The Mall is composed of one level – Ground Level -where books and music CDs are available.

The starting situation opens with the user inside the scenario of the Shopping Mall, at the entrance to the ground level. Starting from this position, he/she may move throughout the whole scenario. When reaching a couple of shelves the user may access to different interactive objects, like a book or a CD.

If the user wants to approach to the cashier to pay the objects he/she has grabbed, it's sufficient to come close to it, and position in the line. In the line there are 3 people and the patient is the last in line. The line will only advance when the psychologist wants.

When any of these persons are paying, the psychologist can bring about a trouble situation. This situation consists in the credit card giving problems, which makes the wait to become longer. When all the people have abandoned the line, it is the patient's turn.

Now he has to pay. In this situation, the psychologist can also cause the trouble situation mentioned previously. Once the trouble situation has ended, the objects will disappear and a paper bag will appear instead.

Another trouble situation that can be generated before or after buying is to provoke a blocking at one of the aisles. When the user goes through the aisle, more people walking will appear, blocking the way out. In the Shopping Mall, the psychologist can also bring about the Heart Rhythm and Breathing Sound effect.

4.2. The use of virtual environments in the treatment protocol

It is important to remind patients that VR allows them to "feel and experience" what happens when coping with a phobic situation, but in a completely safe context.

Patients should be introduced to the system at the first session with a brief explanation of what they are going to do and what they will encounter. For example: "Have you used a computer? Have you ever played a computer game? Have you heard of VR? What we are going to do is very similar. You are going to sit in front of the computer. You will wear this headmounted display and use the mouse. With VR you won't just see a computer screen, you will be "inside" the screen. You will see some rooms or settings where there are different things. The first room is used for training in order to get used to the system. In this room you will learn how to move and interact with the objects. You will encounter different situations as the sessions progress. The advantage of VR is that you are going to do things you don't like or are afraid to do in the real world as well as things that cannot be done in the real world. This means that you can practice the activities you find difficult to perform in the real world. The most important part is that you will not be alone there because I will be with you all the time. We will be in the same settings and situations together. It's a great opportunity to do all the things you normally avoid. Is there anything you would like to know before we begin?"

It is very important to help patients get inside the situation. Therapists must be careful to contextualize the environments, adapting them to aspects of daily living with short introductory stories ("you are in the bedroom in the apartment you've rented"), speaking in the present tense ("walk around, take a good look at all the furniture"), and stress that the patient is actually experiencing all that is happening in the virtual environment "now".

The context and all the things that can happen should be explained briefly before each new situation. For instance, the sounds or movements the system makes: what's happening? What do you think that noise means?

5. Large-scale clinical trial

As we have already mentioned in this chapter, we have carried out a study to offer data about the differential efficacy and effectiveness of Virtual Reality exposure vs. In vivo exposure in the treatment of panic disorder and agoraphobia. In this section we describe briefly the study and the results obtained.

5.1. Experimental design

To achieve the main goal of our research we will compare the effectiveness of several control and experimental conditions. We established one control condition, a Waiting List (WL). The patients in this condition were assigned to the treatment conditions afterwards.

We established 2 experimental or treatment conditions. One of the treatment conditions was a cognitive-behavioral program that includes VR as the exposure component (VRE).

The other treatment condition was a cognitive behavioral program that includes In Vivo as the exposure component (IVE).

The procedure to carry out this experimental design is as follows:

In a first intake we contacted possible participants who meet DSM-IV [7] of PDA among people who asked for help in Jaume I University Anxiety Disorders Clinic or among people referred to our clinic by other mental health professionals.

The patients were assigned to the WL control condition or to one of the two treatment conditions: VR or In vivo exposure. All patients were assessed at pre-treatment.

Then, patients in the treatment conditions started the treatment that lasted about six to eight weeks. Then they were assessed at post-treatment and at 3-month and 9-month follow-up.

The patients in the WL waited six to eight weeks without being treated. Then, they went through a second assessment and they were assigned to one of the treatment conditions.

5.2. Participants

The sample was initially composed by fifty people who met DSM-IV [7] criteria for panic disorder with or without agoraphobia. Three participants dropped out during the assessment phase. The rest, forty seven, started the treatment. Seven patients improved after the first treatment component, the educational component. They were not included in the comparison between VR exposure and in vivo exposure. Therefore, the final sample was composed by forty patients who were randomly assigned to three experimental conditions: 1. Waiting list control: 12 patients; 2. In vivo exposure treatment: 14 patients; 3. VR exposure treatment: 14 patients.

Patients in the waiting list condition were assigned to the treatment conditions after the waiting list phase: Eight have completed the waiting list phase and have been assigned to the treatment conditions, although they have not completed the treatment yet. Four are still in the waiting list phase.

Three more patients initially assigned to the treatment conditions have not completed the treatment yet.

Twenty five patients have completed the follow-up assessment in different moments: we have data so far of 11 patients at three-months follow-up, data of 10 patients at six months follow-up, and data of four patients at nine-months follow-up.

In table 9 and 10 we present the sample description (N = 40) attending to demographic and clinical features.

5.3. Assessment

A detailed description of the assessment protocol and procedure can be found in section 3.1. of this chapter.

Table 9: Demographic features

	Mean (SD) or (%)
Age	33.74 (11.80)
Gender	
Males	27.5%
Females	72.5%
Marital status	
Single	32.4%
Partnered	13.5%
Married	51.4%
Divorced	2.7%
Educational status	
Elementary school	21.6%
High school	43.2%
College	35.1%

Table 10: Clinical features

	(%)		(%)
Diagnosis		Comorbidity Axis II	
PD	15.4%	YES	8.1%
PDA	79.5%	NO	91.9%
AG	5.1%		
Comorbidity: Axis I		Medication	
YES	29.7%	Non	38.2%
NO	70.3%	Antidepressants	5.9%
		Anxiolytics	41.2%
		Both	14.7%
Secondary diagnosis axis I		Clinical status (severity) rated by	
Other anxiety disorder	44.44%	therapist at pre-treatment	
Mood disorder	44.44%	Mild	16.7%
Hypochondriasis	11.11%	Moderate	43.3%
		Severe	26.7%
		Very severe	10%

PD: Panic disorder; PDA: Panic disorder with agoraphobia; AG: Agoraphobia without history of panic disorder.

5.4. Treatment

The treatment lasts nine sessions. Given that the main goal of this trial is to show data about the use of the exposure component (comparing in vivo exposure vs. VR exposure) we have focused in the exposure component. A more detailed description of the treatment can be found in section 3.2. of this chapter.

5.5. Results

In this section we will summarize very briefly the results obtained in the large-scale clinical trial conducted in the VEPSY project so far. A more detailed description of the final results can be found in Botella, Villa, Garcia-Palacios, Banos, Quero, Alcaniz & Riva (submitted) [43].

Regarding the measures related to the axis 1 or efficacy axis, our data so far showed that VR exposure and in vivo exposure achieved a similar efficacy and both were significantly more efficacious than the waiting list group in measures directly related to panic disorder and agoraphobia, general psychopathology, and impairment.

As for the measures related to the axis 2 or effectiveness axis, both treatment conditions seemed equally effective regarding the expectations and satisfaction related to

the exposure component, the improvement rated by both the clinician and the patient, and the clinical status evaluated by the clinician.

5.6. Discussion

In this section we will discuss briefly the results of our large-scale clinical trial. We will do so taking into account the clinical guide (*Template for Developing Guidelines: Interventions for Mental Disorders and Psychosocial Aspects of Physical Disorders*) that has been developed by the committee of experts of the *American Psychological Association* within the framework for "empirically valid treatments or treatments based on evidence" [9]. This guide recommends to consider two "Axes": the efficacy Axis, or axis of internal validity, which entails analyzing the scientific evidence that is available for any given intervention, and the effectiveness, or clinical utility Axis, which entails analyzing the possibility of the intervention in the specific context in which it has to be offered [12, 13].

With regard to the efficacy axis, our data suggest that VR exposure and in vivo exposure showed more efficacy than a waiting list control group in the treatment of panic disorder and agoraphobia. Both treatment groups showed a significant improvement in all measures comparing with the control condition. The two treatment conditions showed a similar efficacy. There were no significant differences between VR exposure and in vivo exposure in measures directly related with panic disorder and agoraphobia:

As for the measures regarding effectiveness, that is, those measures more related with clinical utility, both treatment groups were equally effective regarding expectation and satisfaction with the exposure component. Also, clinicians rated the global clinical state of the patients and the improvement achieved similarly in both treatment conditions. The patients also rated their improvement similarly in the VR group and the in vivo group.

6. Conclusions and future directions

The main conclusion of our large-scale clinical trial is that we have developed an exposure component using VR that shows a similar efficacy and effectiveness than the exposure component of choice for panic disorder and agoraphobia: in vivo exposure.

As we have already mentioned, VR exposure presents several advantages compared with conventional in vivo exposure to treat panic disorder and agoraphobia. In in-vivo exposure patients undergo graded exposure to what they fear most with the help of a psychologist. In comparison with this type of technique, in VR the therapist can control the feared situations at will and with a high degree of safety for the patient, as it is easier to grade the feared situations. Another advantage is that VR is more confidential because treatment takes place in the therapist's office, and patients need not fear "making a spectacle of themselves" in public or simply that their problem might be known. Besides, it is much cheaper as it takes place in the therapist's office, and considering the wide number of situations and activities that agoraphobic patients use to avoid, VR can save time and money significantly.

Another advantage of our VR exposure program for the treatment of panic disorder and agoraphobia is the possibility of doing VR interoceptive exposure. Interoceptive exposure consists of exposing patients to bodily sensations similar to the ones experienced in their panic attacks. This can be achieved carrying out several tasks in the consultation room, such as hyperventilate, jumping, blowing through a straw, running, etc. VR could be

a more natural setting for interoceptive exposure than the consultation room because we can elicit bodily sensations while the patient is immerse in VR agoraphobic situations.

Finally, we think that VR exposure can be a useful intermediate step for those patients who refuse in vivo exposure because the idea of facing the real agoraphobic situations is too aversive for them. We think that making those patients go through a VR exposure treatment can increase the likelihood that they accept an in vivo exposure program afterwards.

All this advantages has guide our work regarding the design and testing of a VR exposure program for panic disorder and agoraphobia. Our data support that our VR program achieved a significant improvement in important panic disorder and agoraphobia measures. The treatment was also effective, that is participants and therapists showed a good acceptance and satisfaction related to the VR exposure component.

There is some more research to be carried out after these findings. We would like to highlight the next steps to follow:

1. Complete the treatment and assessments of all the participants.
2. Wait for the one-year follow-up assessment to state that our VR exposure component is effective at long-term.
3. During this project we have designed a telepsychology program, to assist the virtual reality exposure program, but we have not tested its use and its effectiveness in the treatment of panic disorder and agoraphobia yet. One of our future research aims is to test the efficacy and effectiveness of this tool.

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6 Virtual Reality Exposure in the Treatment of Social Phobia

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Abstract. Social phobia is one of the most frequent psychiatric disorders and is accessible to two forms of scientifically validated treatments: anti-depressant drugs and cognitive-behavioral therapies. Graded exposure to feared social situations (either *in vivo* or by imagining the situations) is fundamental to obtain an improvement of the anxious symptoms. Virtual reality (VR) may be an alternative to these standard exposure techniques and seems to bring significant advantages by allowing exposures to numerous and varied situations. Moreover studies have shown that human subjects are appropriately sensitive to virtual environments.
This chapter reports the definition of a VR-based clinical protocol and a study to treat social phobia using virtual reality techniques. The virtual environments used in the treatment reproduce four situations that social phobics feel the most threatening: performance, intimacy, scrutiny and assertiveness. With the help of the therapist, the patient learns adapted cognitions and behaviors when coping with social situations, with the aim of reducing her or his anxiety in the corresponding real life situations.
Some studies have been carried out using virtual reality in the treatment of fear of public speaking, which is only a small part of the symptomatology of most of social phobic patients. The novelty of our work is to address a larger group of situations that the phobic patients experience with high anxiety. In our protocol, the efficacy of the virtual reality treatment is compared to well established and well validated group cognitive-behavioral treatment.

1. Introduction

Virtual Reality (VR) is a human-computer interaction paradigm, in which users are no longer mere external observers of images on a computer screen, but the active participants in a three-dimensional (3D) virtual world. Virtual reality allows the presentation of virtual objects to all of the human senses in a way identical to their natural counterpart [1]. Virtual reality also offers a variety of tools and approaches that can be used to understand human emotional responses and the psyche [2].

For all these capabilities therapists take now interest in virtual environments and do not hesitate to envisage their use in Psychotherapy. "Three important aspects of VR systems offer new possibilities for assessment and treatment" [3]: Monitoring of movements or actions from any body part or many body parts at the same time and process

of these actions and signals; Translation of feedback and prompts into alternate senses for users with sensory impairments; Location of patients in environments that would otherwise be dangerous or inaccessible or would generate too much stress for effective therapy. The idea of using VR technology to treat psychological disorders was first conceived at Clark Atlanta University in 1992. Since then, experiments have been successfully conducted, especially in the treatment of specific phobias [4].

Cognitive and behavioral therapy techniques for treating phobias include graded exposure of the patient to anxiety-producing stimuli (Systematic desensitization).

Traditionally exposure therapies are carried out either *in vivo*, the patient experiences real situations, either through the patient's imagination. But patients may experience difficulties to imagine or aversion for the real situation.

Virtual Reality Therapy (VRT) brings advantages allowing exposure therapy and overcoming some of the difficulties inherent in the traditional treatment. VRT is an innovative alternative or support treatment for patients. It gives the therapist greater control over multiple stimulus parameters. It also provides the ability to isolate the specific parameters that determine the dysfunctional response. Like *in vivo* therapy, VRT can provide stimuli for patients who have problem with guided imagery. It can be used as an intermediate step in preparing patient for maintenance therapy involving self-directed *in vivo* exposure. Finally, safer and less threatening than *in vivo* desensitization, preserving privacy, VRT is well accepted by the patients.

Based on data collected and subjects' verbal reports, North and al. [4] made a few assertions, very useful for the therapy definition but also for the description and the design of the virtual environments:

- A person's experience of a situation in a virtual environment may evoke the same reactions and emotions as the experience of a similar real world situation.
- A person may experience a sense of virtual presence similar to the real world even when the virtual environment does not accurately or completely represent the real-world situation.
- Each person brings his/her own background into a virtual reality experience.
- Experience with a virtual environment increases the participant's sense of virtual presence.
- The sense of presence in virtual and physical environments is constant and subjects have to give up the sense of presence in an environment (e.g. physical) to achieve a stronger sense of presence in the other one (e.g. virtual).
- Subject concentration increases significantly in the virtual world as compared to in the physical world, when the subject has enough interaction to develop a strong sense of virtual presence.
- A person's perceptions of real-world situations and behavior in the real-world may be modified based on his/her experiences within a virtual world.

Nevertheless, the potential risks associated with VR technology should not be neglected and some precautions should be taken [5]. Subjects at risk for psychological harm are those with serious medical problems such as heart disease or epilepsy, those who are taking drugs with major effects. Experience of symptoms ranging from headache to epileptic seizure may occur after exposure to visual stimuli. Some precautions in the installation of the patient should also be taken to increase his/her safety, such as to sit on a chair rather standing up or to keep the sessions brief [4].

As studies showed that Virtual Reality exposure can be effective with relatively cheap hardware and software on stand-alone computers currently on the market [6], we can

reasonably assert that virtual reality exposure will come within reach of the ordinary practitioner within the next few years.

2. Description of Social Phobia

According to the DSM IV [7] and CIM 10 [8], social phobia is the unreasonable or excessive fear of social situations and the interaction with other people that can automatically bring on feelings of self-consciousness, judgment, evaluation, and inferiority.

Put another way, social phobia is the fear and anxiety of being judged and evaluated negatively by other people, leading to feelings of inadequacy, embarrassment, humiliation, and depression [9].

It has been estimated that 3 to13 percent of people suffer from a social phobia during some period of their lives [10]. The percentage suffering from a social phobia at any one time is 1 to 2,5 %. Shyness is much more common. Studies have shown that 80-90% of people say they have felt shy at some time in their lives. And 30-40 % consider themselves shy at the present time. Social phobia generally appears between the ages of fifteen and twenty and is about equally in women and men [11].

It is distinguished the *specific* social phobia (e.g. fear of speaking in front of groups), and the *generalized* social phobia where people are anxious, nervous, and uncomfortable in almost all social situations. It is much more common for people with social phobia to have a generalized type of this disorder. When anticipatory anxiety, worry, indecision, depression, embarrassment, feelings of inferiority, and self-blame are involved across most life situations, a generalized form of social phobia is at work [12].

People with social phobia usually experience significant emotional distress in the following situations: being introduced to other people, being teased or criticized, being the centre of attention, meeting people in authority ("important people"), most social encounters, especially with strangers and so on.

The physiological manifestations that accompany social phobia may include intense fear, racing heart, turning red or blushing, excessive sweating, dry throat and mouth, trembling, swallowing with difficulty, and muscle twitches, particularly about the face and neck. Constant, intense anxiety that does not go away is the most common feature sense.

This pathology is often accompanied by significant social disabilities and exposes the subject to severe complications (depression, suicide, alcoholic behaviors, etc) [12].

The development of social phobia has not yet been fully explained. It is unlikely that a social phobia arises suddenly as a result of a particular negative experience (trauma).

Various possible factors have been suggested: social learning, defective social skills, biological and genetic factors.

3. Traditional approaches

If this disorder has long been ignored, it is now – and this for 15 years or so – the object of an intensive research. It has been shown that two forms of treatment may well be of value in social phobia [13]: drugs [14] and cognitive-behavioral therapy [15].

3.1 Drugs treatment

Drugs exist that are helpful in depression (antidepressants). A certain class of antidepressants (reversible inhibitors of monoamine oxidase-A or RIMAs) is also effective in social phobia. Physical symptoms of tension can be redacted with drugs known as beta-

blockers. These are often prescribed for occasional use in situations it is feared that physical symptoms may occur (e.g. fear of trembling when giving a speech or musical recital). The chances of achieving lasting positive effects by the use of antidepressant drugs are increased by supplementary behavior therapy.

3.2 Cognitive-behavioral therapy

Cognitive-behavioral therapy is a form of treatment that is strongly oriented towards reducing symptoms [16]. A careful investigation is always made to determine how the symptoms have arisen and what keeps them going. Treatment is then given according to a structured plan. The behavior therapist chooses methods and techniques that studies have shown to be effective in combating such symptoms. Patients are given assignments that must be completed at home. Between sessions the patient records all kinds of information and does practical exercises. Step by step, increasingly more difficult situations are practiced.

Three aspects must be distinguished in the cognitive-behavioral therapy of social phobia [17]:

- Dealing with anxiety-provoking thoughts

Dealing with anxiety-provoking thoughts is also known as cognitive therapy. The first step is to track down negative thoughts that are then examined to see whether they are justified. If possible, they are replaced by more realistic, and often more positive thoughts.

- Acquiring social skills

It has been shown that some people with a social phobia become anxious because they have defective social skills. The risk of rejection is greater if someone does not know how to initiate a conversation or turn down a request. Acquisition of social skills is usually carried out in groups. Social behavioral options are discussed, demonstrated and practiced by role-playing.

- Overcoming avoidance

Behavioral therapy cannot be successful unless avoidance is overcome. A highly effective approach is the use of "exposure exercises" [18], [19]. In this case, the patient is exposed to situations that arouse anxiety. Usually the patient starts with something easy. This exercise is then followed by increasingly difficult situations. Someone with social phobia will practice, for example, by going to a party, or drinking something in a café.

Another key element in virtually all anxiety and phobia treatments based on behavioral therapy is the use of relaxation exercises [20]. This reduces physical tension, making other exercises less difficult.

Cognitive behavioral therapies (CBT) act in three different ways [17]:

- Through a regular and prolonged confrontation of the subject to anxiety-producing social situations (exposure therapy)
- Through a modification of the subject thoughts and of her/his assessments of social situations (cognitive therapy)
- Through the learning of more efficient relational behaviors (assertiveness therapy).

Studies cannot exactly determine which of these three components is the most efficient to reduce the social anxiety of phobic subjects. However, it seems that the exposure to feared social situations – especially if the subject learns how to modify his/her thoughts and

certain of his/her behaviors) is fundamental to obtain an improvement of the anxious symptoms [21].

4. The new VR-based treatment

Cognitive and behavioral therapy techniques include exposure to anxiety-producing situations. So most of the therapies treating phobias and using virtual reality are drawn on the principle of exposure consisting in confronting and accustoming the patient to the stress situations [22, 23]. This technique attempts to mock the *in vivo* exposure that is normally executed in the real world.

Case studies demonstrated the effectiveness of exposure carried out through Virtual Reality. Only few studies reported VR applied to social phobia [23-26]. More exactly, these studies dealt with the fear of public speaking, which is one of the situations frequently met by social phobics. The aim was to expose people to negative, positive, and neutral audience. The results showed a positive correlation between the kind of audience, the self-rating and the public speaking anxiety. But social phobics can meet difficulties in other social situations than the fear of public speaking.

Using artificial settings, virtual reality eliminates many constraints of the real world and therefore seems to be a tool that brings significant advantages. One of the principal assets of virtual reality is the possibility for the therapist of controlling the intensity of the stimuli (e.g. variations of the stress situations, addition of new sources of stimuli: tactile, visual...) in order to make progress in a continuous and soft way for the patient. In addition, the patient as well as the therapist has the possibility to stop immediately the simulation in the event of faintness. It is not the case in the *in vivo* exposure where it can be difficult or take some time to stop the therapy. VR exposure, which we call *in virtuo* exposure here, can be a useful intermediate step for social phobics who feel aversion to face real world situations. Moreover all the therapy is carried out in the therapist's office, and the indispensable confidentiality is preserved [27].

In imaging exposure, the patient has to imagine the anxious stimuli. However, it is proved that several of them cannot or are too phobic to imagine the situation prescribed by the therapist. Moreover, one does not know what the patient imagines really.

According to the knowledge of potential risks related to either major organic health problems such as heart disease, or either other mental disorders such as depression, or either side effects of VR use such as headaches, definite steps must be taken in treatment to minimize these risks [4]. Special attention must be paid to the elimination of some treatments which could distort the action of the Virtual Reality Therapy.

We took all these advantages and potential risks into consideration in the definition and the design of a new VR-Based treatment of social phobia [28], in which the presence of the therapist is fundamental to assure the safety of the patient. It may appear as a first step in a new way of therapy and the conclusions of the large scale clinical trial should give issues for its improvement.

5. The VR-based clinical protocol

The objective of this study is to assess the efficiency of a virtual reality therapy (VRT), compared to a validated psychological treatment (CBT: cognitive behavioral therapy) [29].

5.1 Studied population

The studied population is formed of patients showing a social phobia according to the diagnostic criteria of the DSM IV and complying with inclusion and non-inclusion criteria, such as those defined here:

- *Inclusion criteria :* Men and women, at least 18 years old and at most 65 years old, ambulatory, social phobics since least two years and at most 25 years.
- *Non Inclusion criteria:* In terms of population (Pregnant women), of pathology (severe organic disease, mental disorder of an organic origin, depression), and of treatment (with an active medicinal treatment against social phobia that is not stabilized, other kind of psychotherapy).

5.2 Architecture of the study

In an open study we compared two types of treatment – virtual reality therapy and cognitive-behavioral therapy – for ambulatory patients showing a social phobia. Two groups of patients are formed and compared: a "VRT" group and a "CBT" group.

The allocation of patients to one of these two groups was done according to some constraints (more specifically the ability to use computers and virtual reality software) while ensuring of the homogeneity of the two groups in terms of significant criteria (sex and age of the patient, duration and severity of the social phobia estimated by the Liebowitz's scale). We did not retain the principle of randomization because of organization's constraints: the calendar of cognitive-behavioral therapies, the limited number of social phobics, and the calendar of the study.

We worked on the basis of the following hypotheses: The virtual therapy group will improve at least as much as the cognitive and behavioral therapy group.

The study was conducted in the Unité de Thérapie Comportementale et Cognitive (Behavioral cognitive therapy unit) of the Sainte-Anne University Hospital (Professors LOO and OLIE), Paris, and extended over 9 months from September 1, 2002 (first inclusions) to May 31, 2003 (end of treatments).

5.3 Assessments

After the diagnostic assessment (DSM IV criteria of social phobia, co-morbidities, associated medicinal treatment), all the patients fill the self-report scales described below before the first session (pre-treatment assessment) and after the last session (post-treatment assessment).

- Liebowitz Social Anxiety Scale (LSAS) [30]

It is a self-report questionnaire consisting of 24 items that has been used in different studies on social phobias. It is resorted to assess social phobia symptoms. Patient fear or anxiety is rated from 1 (none) to 4 (severe) their avoidance from 1 (never or 0%) to 4 (currently or 68 to 100%) in 24 different situations. Eleven of these situations correspond to social fear or anxiety and 13 to performance fear or anxiety.

- Zigmond and Snaith Hospital Anxiety Depression Scale (HAD) [31]

It is a self-report questionnaire consisting of 14 items. For each of these items, the subject chooses amongst 4 proposed answers ranging from 0 to 3. 7 items explore the patient anxiety level and 7 items the depression level.

- Short Beck Depression Inventory (BDI -13) [32]

This self-report questionnaire estimates the depressive semiology with 13 items. Each item is constituted by four statements corresponding to four degrees of increasing intensity of a symptom. The global score is obtained by adding each item's score and allows to establish four degrees of gravity of the depression (none, mild, moderate, severe).

- Rathus Assertiveness Schedule [33]

It is a self-report questionnaire enabling to measure the degree of assertiveness. 30 items, under the form of assertions concerning the way of behaving in different social situations are proposed. The subject must indicate to which degree these assertions are typical of him/her and selecting one of the 6 possible answers ranging from +3 (really typical) to –3 (really not typical).

- Social Interaction Self Statement Test (French adaptation TAPIS by Cottraux) [34]

This self-report questionnaire estimates the frequency of positive thoughts or negative thoughts arising in the context of social relationships. Each of 30 items is rated from 1 (I almost never have this thought) to 5 (I have this thought very often).

- Questionnaire on social contexts inducing anxiety [10]

This questionnaire enables to establish the typology of the social phobia (focused or generalized phobia, and type of subgroup: performance, assertiveness, intimacy or scrutiny anxiety). For each of these four types of social phobia, the patient should evaluate the degree of her/his anxiety (none, light, strong or extreme).

- Sheehan Incapacity Scale [35]

It consists of a scale assessing the quality of life of the patient and filled by the therapist. It rates the disability according to three dimensions, that is: job, social life/leisure, and family life/home responsibilities. Each of these elements is rated from 0 (no disability) to 10 (very severe disability).

- Clinical Global Impressions (CGI) of the pathology severity [36]

This scale filled by the therapist is based on scales developed by the Early Clinical Drug Evaluation Unit (ECDEU) and assesses the global severity of the social phobia, excluding any co-morbidity. Patients are rated from 1 (normal, not ill) to 7 (amongst the most severely hit). The reference point being the experience the therapist has of this population.

- Clinical Global Impressions of change [36]

This scale is based on scales developed by the ECDEU. It assesses the significance of the patient change relatively to the initial situation. The primary dimension is social phobia excluding any other co-morbidity. Patients are rated from 1 (very clear improvement) to 7 (very clear aggravation). This scale is not used in "pre" but only in "post" and in "follow-up". Two versions of this scale are used. One concerns the assessment of the patient by him/herself and the other by the therapist.

The score obtained on the Liebowitz Social Anxiety Scale is retained as the main criteria for the statistical analysis of the results. The rates on the other scales are considered as secondary criteria.

5.4 Therapeutic group definition

36 patients were included in our study: 18 patients were allocated in the "virtual reality therapy" group (VRT) and 18 patients in the "cognitive behavioral therapy" group (CBT). All the patients were submitted to clinical and psychometric "pre" and "post" assessments.

Each patient of the VRT group attended 12 sessions of virtual therapy. Each session was individual and directed by a cognitive behavioral psychotherapist. During these weekly sessions of 45 min, the patient was exposed to virtual worlds in a purpose of assessment or therapy. The duration of exposure was less than 20 min.

Each patient of the CBT group attended 12 sessions of cognitive behavioral therapy in a group of approximately 8 persons. These weekly sessions of 2 hours were directed by a cognitive behavioral psychotherapist.

5.5 Presentation of the Virtual Therapy

- **Virtual exposure situations**

We selected four exposure situations and we designed four virtual environment story boards. Each one corresponds to a special recognized case of social anxiety and its purpose is to reduce the patient's unease in the corresponding real situations:
Story board #1 deals with Assertiveness anxiety, and its objective is "Protecting one's interests, viewpoints, being respected".
Story board #2 deals with Intimacy anxiety, and its objective is "Establishing contacts, next-door neighbor, friends, and small talk".
Story board #3 deals with Observation anxiety, and its objective is "Acting while being observed, being under scrutiny".
Story board #4 deals with Performance anxiety, and its objective is "Speaking in public".

- **Structure of the virtual therapy sessions**

During the first session, the therapist introduces and presents the therapy to the patient. She/he familiarizes with the virtual world and the tools in a neutral environment. The eleven remaining sessions constitute the core of the therapy. They repeat a same structure and use the virtual environments and social situations in the same way. The same virtual environment is used during two consecutive sessions: sessions 2 and 3 with performance, session 4 and 5 with intimacy, session 6 and 7 with scrutiny, and session 8 and 9 with assertiveness. Even sessions consist of an introduction, a clinical interview, a virtual exposure to the environment to assess the patient, a prescription of tasks to carry out between the sessions, and a conclusion of the session. Odd sessions consist of an introduction and the results of the tasks, two virtual exposures to the environment for therapy, a prescription of tasks to carry out between the sessions, and a conclusion of the session.
At the end of each session, the therapist prescribes the patient tasks to carry out in order to apply what was learned during the VR session.
During sessions 10, 11 and 12, after the introduction and the results of the tasks, the patient is exposed to an environment chosen by her/himself, and a conclusion is given.

- **Content of the virtual therapy sessions**

Virtual therapy sessions were conducted according to three modes: "assessment", "spontaneous", and "instructed". The two latter modes correspond to the therapeutic parts.

"Assessment" sessions: During the navigation in the virtual world, the therapist explores the patient's reactions with questions related to:

- The cognitive domain – *What thoughts do you have?* - Assessment concerning a "menace" of the environment; Assessment concerning "resources" to face them.
- The emotional domain – *What do you feel?* - Presence of an emotion; Intensity of the emotion
- The behavioral domain – *What do you do?* - Avoidance or confrontation; Passive or aggressive behaviors

"Spontaneous" sessions: While the story board unfolds, the therapist lets the patient act and move about on his/her own in the world and decides himself/herself which behaviour to adopt.

"Instructed" sessions: During the navigation, the therapist instructs the patient which attitudes are relevant to the situation. The therapist helps the patient learn adapted reactions in relation with Behaviors (Confrontation to a situation, assertiveness), Cognitions (Cognitive therapy), and Emotions (Relaxation).

- **Description of the tasks to carry out between the sessions**

After each session of virtual therapy, the patient should carry out prescribed tasks in order to apply the principles developed and experimented during these sessions, namely Progressive, repeated and prolonged exposure to usually avoided social situations; Development of behaviors adapted to the faced social situations (asserted behaviors and fight against behavioral "micro-avoidance") ; Cognitive work (identification of inappropriate cognitions appearing in social situation and modification of these cognitions).

These tasks are based on the principle of the cognitive and behavioral therapies and allow to practice in vivo what was experienced in a dummy situation (in the virtual world); to facilitate the cognitive behavioral learning process. They are, in their general outline, completely comparable to those prescribed to the patients of the cognitive and behavioral therapeutic group.

5.6 Presentation of the Cognitive Behavioral Therapy

The CBT was carried out with groups of approximately 8 patients. This group format enables to create multiple social situations that may be used during the exposure exercises.

- **Structure of the cognitive behavioral therapy sessions**

During the first session, the therapist introduces and presents the therapy to the patient, then identifies the social situations creating anxiety. All the sessions begin with an introduction and the results of the tasks carried out between the sessions, and end with a prescription of tasks. Sessions 2 to 4 consist of exposure exercises to social situations. In sessions 5 and 6, work on avoidances is added. Sessions 7, 10 and 11 are full situations with exposure exercises, work on avoidances and work on cognitions. During sessions 8 and 9, the patient works only on cognitions. Session 1é, the last one, allows, for each patient, the definition of the medium-term objectives and the elaboration of a personal program. A conclusion is given.

Table 1 presents the comparison between the structure of VRT and that of CBT.

- **Description of the tasks to carry out between the sessions**

These tasks are, in their general outline, completely comparable to those prescribed to the patients of the virtual reality therapeutic group.

Table 1. Structure comparison between VRT and CBT

VRT	CBT
Session 1 Introduction and presentation of the therapy The patient gets familiar with a neutral VE	**Session 1** Introduction and presentation of the therapy Identification of social situations creating anxiety
Session 2 Introduction Virtual exposure to story board 1 for ASSESSMENT Virtual exposure to story board 1 for THERAPY Prescription of tasks to carry out and session conclusion	**Session 2** Introduction Exposure exercises to social situations Prescription of tasks to carry out and session conclusion
Session 3 Introduction and results of the tasks Virtual exposure to story board 1 for THERAPY Virtual exposure to story board 1 for THERAPY Prescription of tasks to carry out and session conclusion	**Session 3** Introduction and results of the tasks Exposure exercises to social situations Prescription of tasks to carry out and session conclusion
Session 4 Introduction and results of the tasks Virtual exposure to story board 2 for ASSESSMENT Virtual exposure to story board 2 for THERAPY Prescription of tasks to carry out and conclusion	**Session 4** Introduction and results of the tasks Exposure exercises to social situations Prescription of tasks to carry out and session conclusion
Session 5 Introduction and results of the tasks Virtual exposure to story board 2 for THERAPY Virtual exposure to story board 2 for THERAPY Prescription of tasks to carry out and session conclusion	**Session 5** Introduction and results of the tasks Exposure exercises to social situations and work on avoidances Prescription of tasks to carry out and session conclusion
Session 6 Introduction and results of the tasks Virtual exposure to story board 3 for ASSESSMENT Virtual exposure to story board 3 for THERAPY Prescription of tasks to carry out and session conclusion	**Session 6** Introduction and results of the tasks Exposure exercises to social situations and work on avoidances Prescription of tasks to carry out and session conclusion
Session 7 Introduction and results of the tasks Virtual exposure to story board 3 for THERAPY Virtual exposure to story board 3 for THERAPY Prescription of tasks to carry out and session conclusion	**Session 7** Introduction and results of the tasks Exposure exercises to social situations and work on avoidances Work on cognitions: identification of one's cognitions Prescription of tasks to carry out and session conclusion
Session 8 Introduction and results of the tasks Virtual exposure to story board 4 for ASSESSMENT Virtual exposure to story board 4 for THERAPY Prescription of tasks to carry out and session conclusion	**Session 8** Introduction and results of the tasks Work on cognitions: modification of one's cognitions Prescription of tasks to carry out and session conclusion
Session 9 Introduction and results of the tasks Virtual exposure to story board 4 for THERAPY Virtual exposure to story board 4 for THERAPY Prescription of tasks to carry out and conclusion	**Session 9** Introduction and results of the tasks Work on cognitions: modification of one's cognitions Prescription of tasks to carry out and session conclusion
Sessions 10 and 11 Introduction and results of the tasks Virtual exposure to one of the story board selected by the patient (deepening) Virtual exposure to one of the story board selected by the patient (deepening) Prescription of tasks to carry out and session conclusion	**Sessions 10 and 11** Introduction and results of the tasks Exposures to social situations and work on avoidances Work on cognitions: modification of one's cognitions Prescription of tasks to carry out and session conclusion
Session 12 Introduction and results of the tasks Virtual exposure to one of the story board selected by the patient Virtual exposure to one of the story board selected by the patient. Conclusion	**Session 12** Introduction and results of the tasks Definition of the medium-term objectives for each patient Elaboration of a personal program for each patient Conclusion

5.7 Forms and recording tools

Each patient who decides to enter the clinical trial receives an information notice which describes and explains the study. Then she/he fills up an agreement form which specifies all the ethical guarantees. The patient is free to leave the study whenever she/he wants.

For each patient of each of the two groups, all the data, the results of the assessments and the events occurring along the therapy are recorded in an Observation Book specially designed for this study and for the therapist.

5.8 Legal disclaimer

This protocol has been submitted to an ethical committee and has been approved in conformity with the French law.

6. The use of Virtual Environments in the clinical protocol

GREYC-ENSICAEN, Caen, France, designed Virtual Environments (VE) to treat Social Phobia, in close collaboration with the clinical team of Sainte-Anne University Hospital, Paris. According to a precise clinical protocol, the purpose of these VE is to expose patients to social situations inducing anxiety [37].

6.1 Technical characteristics of the platforms

6.1.1 The software

The creation of the 3D virtual environments used in the treatment of social phobia required two main software tools for PC:

- A graphic tool, Discreet 3D Studio Max 4, which is a high-performance graphic application for object design, visual effects production, complex 3D worlds creation. Character Studio 3, an extension of 3DS Max offers the possibility of advanced characters creation and animation.

- A behavior-based interactive 3D development tool, Virtools Dev 2.0 Education, which is an authoring application that allows to create interactive, 3D content; that brings to life imported media; that allows the creation of simple media such as cameras, lights, curves, interface elements, and 3D frames. It is a behavioral engine that processes behaviors, which are descriptions of interactions of elements in an environment. These behaviors are realized by building blocks, which can be combined to create complex interactive behaviors. They can be reusable. Virtools Dev is also a rendering engine that draws the image seen on-screen. Based on information supplied by the behavioral engine, the render engine decides what should be drawn. It is finally a software development kit (SDK) that provides access to the behavioral engine and the rendering engine, which allows, for example, to create and modify behaviors.

6.1.2 The equipment

The environments are running on PC. The files (.vmo) can be viewed with the Virtools Web Player, which can be freely downloaded from the Virtools site (www.virtools.com/downloads/playerie.asp). The system configuration is a PC DELL Dimension 8250, Pentium IV, 2.4 GHz, Windows 2000, Chipset Intel with 533 MHz, 256

MB of DDR RAM with 333MHz, Internet Explorer 5.0, DirectX 7, Monitor color display 17". It is equipped with a sound card, a graphic card nVidia GeForce 4MX AGP 4x, 64MB, and with a 17" monitor.

The patient navigates in the environments using the mouse and the cursor movement keys (up, down, left, right) or a Cyberpuck pad. Resembling a hockey puck, the Cyberpuck is a hand controller which allows the user to navigate the virtual environment with ease as an independent virtual reality controller device, and to interact with the environment.

The virtual worlds are displayed on a large screen monitor. Experiments with a complete immersion can also be conducted. The patient wears a head mounted display (HMD) VFX3D and moves forward or backward with the Cyberpuck pad. The VFX3D is a Virtual Reality System complete with a three degree of freedom tracker for roll, pitch and yaw positioning, standard VGA interface, audio inputs and 360,000 pixel color.

6.1.3 The environments

Four situations have been selected in the protocol and four virtual story boards have been designed. Each one corresponds to a special case of social anxiety and the purpose is to reduce the patient's anxiety in the real situations. Consequently, four virtual environments have been created with the corresponding characters and sounds. A fifth virtual environment was designed, a neutral one, without characters, in which the patient learns how to use the tools, how to navigate. All the instructions are invisible to the patient. The therapist can refer to them in a separate manual.

These virtual environments were born from a close cooperation between the clinical team and the technical team, from a good comprehension of the needs for the ones and possibilities for the others.

- **Environment #0: Training**

Objective: To train the patient to a virtual environment (Figure 1. **Training environment**)

Three rooms with objects such as tables, chairs, bed, pictures on the walls, plant, were created on both sides of a corridor. The patient learns how to move forward, and backward; how to look up, dn, and around; how to open doors; how to sit on a chair in front of a television set.

- **Environment #1: Assertiveness Anxiety**

Objective: the patient learns to protect her/his interests, viewpoints, to be respected (Figure 2. **Assertiveness environment**)

Three main places were created: upstairs, an elevator with two persons who can criticize the patient, downstairs, a hall with three persons who block the exit way and a shoe store with a director and two assistants who will try, repeatedly, to sell shoes to the patient. Between the hall and the shoe store, the patient can also navigate in a street where persons are standing or sitting on benches.

- **Environment #2: Intimacy Anxiety**

Objective: the patient learns to establish contacts with neighbors, friends, to have small talk (Figure 3. **Intimacy environment**)

Figure 1. Training environment

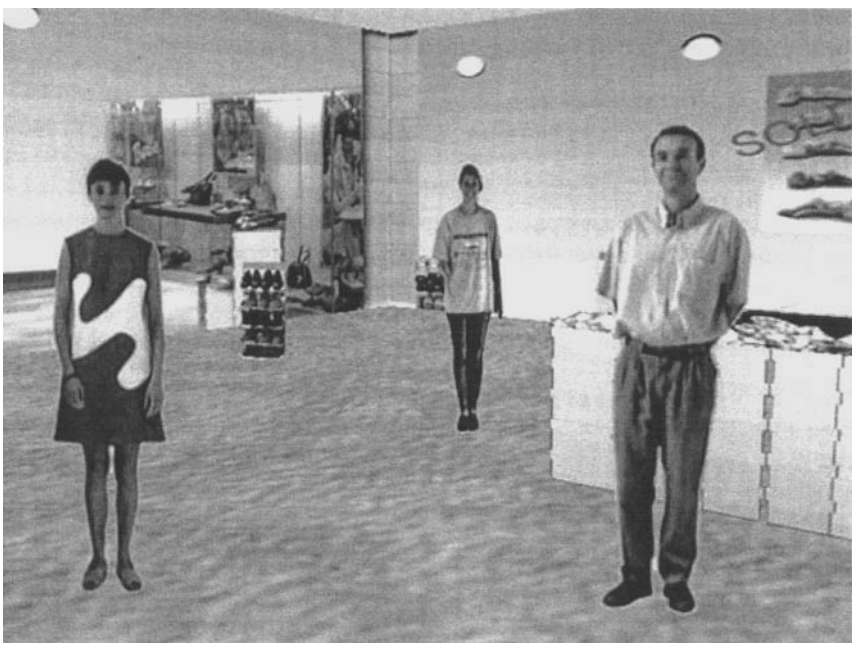

Figure 2. Assertiveness environment

Figure 3. Intimacy environment

The story board takes place in an apartment, showing a table set for dinner, a lounge, a kitchen, and decorative objects such as lamps, shelves, and pictures. A friend invites the patient with four other people. The patient should introduce her/himself, speak about the decoration and answer questions when all the guests will be around the table.

- **Environment #3: Observation Anxiety**

Objective: the patient learns to move, to speak while being under scrutiny (Figure 4. **Scrutiny environment)**
The patient walks from a street lined with trees to a square and the outside of a coffee shop. Many people are looking at her/him, sitting on benches, at the tables, or standing up. The patient should enter the coffee shop, looking for a friend, then go out and reach a free chair next to her/his friend who has just arrived and engage a conversation with him. The waiter will come to take the order, then to collect the bill. There will be a mistake in the sum. In all the situations, the patient will feel being under scrutiny.

- **Environment #4: Performance Anxiety**

Objective: the patient learns to speak in public (Figure 5. **Performance environment)**
The story board takes place in a meeting room where the patient joins seven other participants who are already sitting and speaking around a big table. First s/he should reach a free chair at the table, and after the arrival of the director s/he should present her/himself, then stand up and walk to a paperboard to expose a subject while everybody is looking on attentively or not.

6.1.4 The media

The Virtools rendering tool imposes constraints on the object models to synthesize images in real time and to allow an interactive navigation.

Figure 4. Scrutiny environment

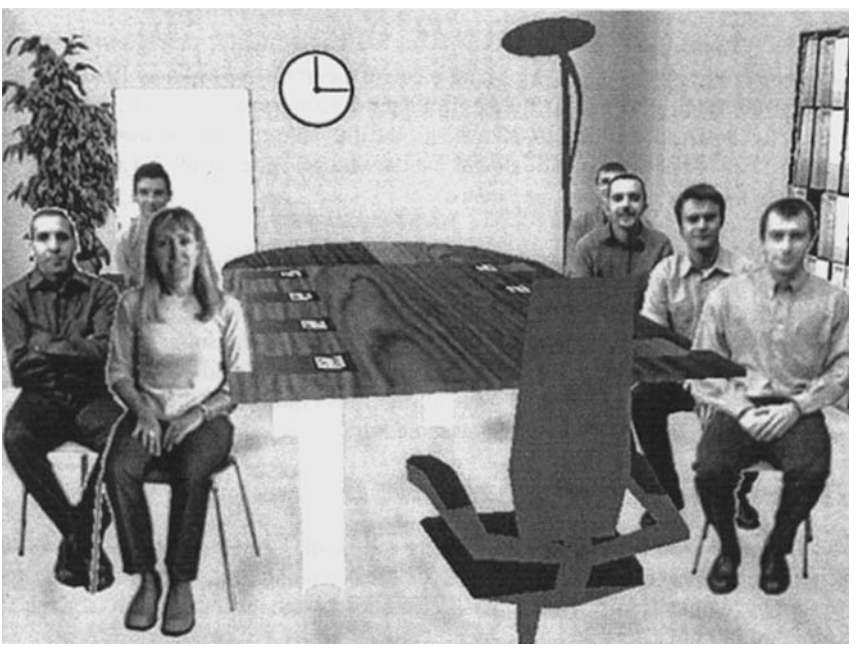

Figure 5. Performance environment

These constraints include the axis orientation, the texture size, the number of vertices and facets, etc. We describe here the design process and the decisions we made to comply with these constraints.

- **3D Objects models**

The virtual environments are full of *3D Objects models*, which were created in 3DS MAX and exported to a Virtools readable format (.nmo). In 3DS MAX, objects are designed from a mesh, constituted of polygons. More these polygons are small and numerous, better is the sensation of realism, but bigger are the files.
Attention was paid to the orientation, the size and the scale of all the designed objects in order to respect the Virtools constraints. We optimized the design to render the virtual world faster. Most of the objects have a simple shape, with a limited number of vertices and faces. Non-visible faces were eliminated. Repeated objects were duplicated in Virtools. In this case, there are two object entities but only one mesh. The new objects always refer to the original mesh so the rendering is faster and it spares disk space. We used invisible objects to detect collisions. When it was not necessary to design 3D objects, we used texture-mapping techniques.

- **3D Sprites**

The characters in our environment are *3D Sprites*, which are simple plain surfaces used to simulate single quad objects with textures. Real persons were filmed in daily life situations via a digital video camera. The pictures were edited in Photoshop and exported to a Virtools readable format. A 3D Sprite can be constrained on one or more axes to always face the camera. This choice was a good trade-off between realism and the number of avatars. The design and the implementation of such a number of biped characters with Character Studio would have been time-consuming.

- **Textures**

The textures are images used to give an element a certain appearance. Realistic textures increase the quality aspect of the environments. However, a trade-off was constantly looked for between the degree of realism and the size of the textures. Attention was paid to their dimensions that should be an integer power of 2 (.tga, .jpg, .png). Although, they are not necessary square.

- **Sounds**

The *sounds* designed in the story boards were recorded in real situations. Attention was paid to the tone of the voices, which had to be gentle, without aggressiveness. We decided to use wav files in order to preserve the quality of the sounds.
We optimized the file size and we stored of all the sounds and some of the 3D Sprites externally to the files. So, for the user, all the files concerning the environment (.vmo, wav, and some .nmo) have to be in the same folder.

6.1.5 The interactivity

Virtools Dev was used to integrate the objects and media – textures, sounds – and to add interactivity to the environments. This has been created using behaviors that can be applied to almost any element in Virtools. Each behavior, when executed, can activate other behaviors through links, characterized by a link delay measured in frames. The propagation of the activation depends on this link delay.

- **Patient's representation**

We let the patient experience the environments from a *first person perspective* without the intermediary of an avatar, which would hinder the identification and the involvement of the patient. The patient is represented by a 3D Frame (a reference point) bound to a camera. Both of them move together because of a hierarchy link, the camera being a child of the frame. The collision tests between the patient and the objects of the environments are managed by the 3D Frame, which is also bound to be on floor.

- **Navigation**

The patient navigates in the environments using the mouse and the cursor movement keys (up, down, left, right) or a Cyberpuck pad. The mouse allows the patient to look around, up and down. The cursor movement keys and the pad allow the patient to move forward (up) or backward (down) or to look around (left and right).
Although the Consortium decided that we will propose a non-immersive therapy, we also conducted experiments with a complete immersion. The patient wears a VFX3D head-mounted display (HMD) that determines the patient's head position and moves forward or backward with the Cyberpuck pad. The images that the patient sees in the HMD also appear on the screen of the computer for the therapist. A driver allowing the use of the Head Mounted Display VFX3D has been developed.

- **Interaction**

Some of the objects of the virtual environments are interactive, such as doors. The patient can open the doors by click on the mouse or the pad when s/he is close to them, thanks to a test of proximity.
We introduced tests of collisions with walls, objects, characters of the environments. In environment#3 (Scrutiny), the patient does not enter in collision with some tables because these tests would have complicated the navigation of the patient between the tables.

We developed some effects such as the "sitting down effect". When the patient has to sit down on an indicated chair, she/he moves towards the chair and, in the proximity of it, the computer takes charge of the installation of the patient (Intimacy, Scrutiny and Performance).

The virtual session always unfolds under the *control of the therapist* who can introduce virtual characters or ambient sounds and manage the progress of the session, according to the story board. All the navigation and interaction details are provided to the therapist through the manual of Social Phobia.

6.2 Use of the VE in the clinical protocol

6.2.1 Virtual exposure

Exposure to feared social situations is fundamental to obtain an improvement of the anxious symptoms [21]. Traditionally, exposure is carrying out *in* vivo or through imagination of situations. Virtual exposure is based on the same rationale as *in vivo* exposure for its application:

- **Exposure to all phobic situations**

The patient is exposed to all the scenarios which are dealing with assertiveness, scrutiny, intimacy or performance anxiety and at last to those that he/she considers the

most threatening. The therapist can decide to repeat, to prolong or to stop the exposure according to the behavior of the patient.

- **Work on cognitions and behaviors**

In a first step all cognitions and behaviors of the patient during her/his progress in the virtual environment are analyzed with the therapist. Then later, with the help of the therapist the patient will learn new ones more adapted to face the feared situations. This work of the patient on her/himself is prolonged during the tasks she/he has to carry out between the sessions.

- **Presence and help of the therapist**

Patients exposed to social phobic situations are always accompanied by a cognitive and behavioral therapist.

It has been shown that human subjects respond appropriately to negative or positive audiences even when they are completely virtual [24]. So we can assume that social phobic patients will feel anxiety and physiological disorders when they will be confronted to virtual environments related to their illness.

6.2.2 Virtual reality treatment

After the clinical assessment (diagnosis of Social Phobia and check of all the inclusion and non-inclusion criteria), the psychiatrist can propose the Virtual Reality Therapy (VRT) to the patient. A psychologist takes then charge of the patient who is subjected to a battery of psychometric assessments before the treatment begins ("pre" assessment), after the treatment ("post" assessment) and if possible, six months later ("follow-up" assessment).

The patient attends twelve sessions of virtual therapy, spread over three to four months. Each session is individual and directed by a cognitive behavioral psychotherapist. During these weekly sessions of forty-five minutes, the patient is exposed to virtual worlds in a purpose of assessment or therapy. The duration of each exposure should be less than twenty minutes. At the end of each session the therapist prescribes the patient tasks to carry out in order to apply what was learned.

6.2.3 Virtual reality sessions

During the first session the therapist introduces and presents the therapy to the patient.

Then the patient familiarizes with the virtual training world and the tools.

The eight next virtual sessions constitute the core of the therapy. After an introduction and a discussion about the tasks carried out, the patient is exposed twice to the same virtual environment in a purpose either of assessment then therapy, either of therapy then therapy. Finally the therapist prescribes the patient tasks and gives a conclusion to the session. During the therapy the patient is exposed to all the environments.

During the last sessions the patient chooses the exposure environment according to her/his specific social phobia for deepening. During session twelve, the last one, a final conclusion is given to the patient.

The virtual reality sessions are conducted according to three phases described in the protocol that are the Assessment phase, and the two therapeutic phases, "Spontaneous" and "Instructed"..

The role of the cognitive behavioral therapist is fundamental in this VR-Based Therapy. The therapist guides the patient through the virtual environments, prescribes

her/him tasks, and receives the patient feedback. It seems that VR reinforces the therapeutic relation between patient and therapist on a collaborative mode.

7. The large-scale clinical trial

7.1 Inclusions evaluation

7.1.1 Inclusion difficulties

The recruitment of the social phobic patients to include in this study was difficult because of several reasons:

- The beginning of the inclusions was related to the approval of the French authority, *Comité Consultatif de Protection des Personnes dans la Recherche Biomédicale* (CCPPRB Paris-Cochin) and to the time schedule of the outpatients' department of Saint-Anne University Hospital, where the Unit of Cognitive and Behavioral Therapy takes place. So we included the first patients in September 2002 and the last one in February 2003 in order to be sure to end the treatments in May 2003. The average duration of treatment is three months. So we had only six months to include the patients.

- Social Phobia is a pathology which is "shamefully" lived by the patients who seldom look for a therapeutic help. Our centre, which is one of the most active in the field of social phobia in France, receives on average two to three new social phobics per week.

- Inclusion and non-inclusion criteria (in particular absence of associated depression, no co-morbidities with other anxious disorders, stabilization of medicinal treatment) forced us to retain only a small percentage of these social phobic patients. The 36 patients, verifying inclusion and non-inclusion criteria, were included in six months, which is about six patients per month.

7.1.2 Inclusion results

In order to preserve the number of patients included in the two therapeutic groups (CBT and VRT), we decided not to place patients in a waiting list and so to carry out a study whose objective is to compare VRT to the validated CBT.

36 patients were included in the study, 18 patients in the CBT group, and 18 patients in the VRT group.

7.2 Subjects

Subjects were consecutive outpatients seeking treatment at the Unit of Cognitive and Behavioral Therapy of the Sainte-Anne Hospital, Paris, France. The patients constituted a young adult population of 19 females and 17 males (Mean age: 31,6 ±8,3) between the ages of 18 and 65 years. According to the protocol, non inclusion criteria were defined in term of population, pathology and treatment to select the participants.

The sample was divided in two groups: the virtual reality therapy group (10 females and 8 males; mean age: 30,5 ±5,06) and the cognitive-behavioral therapy group (9 females and 9 males; mean age: 32 ±10,76).

The study received an ethical approval in conformity with the French law. Before starting the trial, the nature of the treatment was explained to the patients who gave a written informed consent.

7.3 Assessments

According to our clinical protocol, pre and post assessments were carried out for all these 36 subjects, first, by a psychiatrist for the diagnostic assessment and the inclusion of the patient, second by a psychologist, for the psychometric assessments.

Once the patient fit the criteria to enter the study, he/she was asked to fill out the following self-report questionnaires:

- Liebowitz Social Anxiety Scale (SAS)
- Zigmond and Snaith Hospital Anxiety Depression Scale (HAD)
- Short Beck Depression Inventory (BDI-13)
- Rathus Assertiveness Schedule (Rathus)
- Social Interaction Self Statement Test (SISST)
- Questionnaire on Social Contexts inducing Anxiety
- Sheehan Incapacity Scale
- Clinical Global Impressions of the pathology severity (CGI)
- Clinical Global Impressions of change

We remind that the score obtained on the Liebowitz Social Anxiety Scale is retained as the main criteria for the analysis of the results. The rates on the other scales are considered as secondary criteria.

7.3.1 Duration of Social Anxiety

On average, the patients show a 15,7 years old disorder (mean (CBT): 16,4 and mean (VRT): 14,5).

7.3.2 Level of Social Anxiety

Liebowitz mean score is 83,9 (mean (CBT): 78 and mean (VRT): 89,7). Our patients show very high level of social anxiety and consequently an established social phobia, which is severe for some of them. This score is higher for the patients of the VRT group.

The two sub-scores of the Liebowitz scales in the VRT group are also higher than those of the CBT group: anxiety sub-score (mean (CBT): 43,7 and mean (VRT): 48,9); avoidance sub-score (mean (CBT): 34,3 and mean (VRT): 40,7).

The two populations are concerned in the same way with regard to the total mean score for the Questionnaire of Social Contexts Inducing Anxiety (mean (CBT): 8,1 and mean (VRT): 8,3) but also for the various sub-scores: Performance sub-score (mean (CBT): 2,4 and mean (VRT): 2,6), Intimacy sub-score (mean (CBT): 1,9 and mean (VRT): 1,7), Assertiveness sub-score (mean (CBT): 1,8 and mean (VRT): 2,1), and Scrutiny sub-score (mean (CBT): 1,9 and mean (VRT): 1,7).

7.3.3 Level of Anxiety

HAD mean score is 10,3 (mean (CBT): 11,8 and mean (VRT): 8,9). This score is higher for the patients of the CBT group.

7.3.4 Level of Depression

BDI-13 mean score (5,5) is relatively low (mean (CBT): 6,3 and mean (VRT): 4,7). It confirms that we do not have a population of depressed patients.

We find again this difference in the HAD depression sub-score (5,7) (mean (CBT):6,2 and mean (VRT): 5,1).

7.3.5 Level of Assertiveness

Rathus Assertiveness mean score (-27,3) is relatively low. The two populations are quite similar (mean (CBT): -26,9 and mean (VRT): -27,8).

7.3.6 Severity of the disease

According to Clinical Global Impressions questionnaire, the two populations appear equally affected (mean (CBT): 4,7 and mean (VRT): 4,8). It shows again that our patients are suffering from an important social phobia.

7.3.7 Handicap

The two populations seem to show same levels of handicap in Sheehan Scale. The handicap in the social field is the higher for the two populations (mean (CBT): 7 and mean (VRT): 7,4), followed by the handicap in the professional field (mean (CBT): 6,2 and mean (VRT): 5,9). The handicap in the family field seems to be lower (mean (CBT): 4,9 and mean (VRT): 4,4).

7.3.8 Conclusion

The studied population is composed of young adults showing an important social phobia, being developed since many years. According to the Liebowitz Scale, the VRT group patients are appreciably more socially anxious than the CBT group patients. However there are fewer differences between the two groups in the other anxiety evaluation criteria.

7.4 Treatment

The patients were allocated to Virtual Reality Therapy group (VRT) or to Cognitive Behavioral Therapy group (CBT) and experienced their therapy as described in *paragraph X.5*. They attended twelve sessions of therapy, spread over three to four months, and directed by a cognitive and behavioral therapist.

The patients of the VRT group attended individual sessions of 45 minutes, which includes 20 minutes of exposure to the virtual environment. As described in *paragraph 5.5*, through the duration of the therapy, the patients were exposed to all the four scenarios, dealing with assertiveness, intimacy, performance or scrutiny anxiety, in a purpose either of assessment, or either of therapy. The assessment phase contains questions to explore the cognitions, the emotions and the behaviors of the patient. The therapeutic phases mix "spontaneous phase" during which the patient moves about freely in the world and decides himself/herself which attitudes to adopt, and "instructed phase" during which the therapist instructs the patient which attitudes are relevant to the situation. The therapist helps the patient to learn adapted reactions in relation with cognitions, emotions, and behaviors.

The patients of the CBT group attended sessions of two hours, in a group of eight to ten social phobics. This group format enables to create multiple social situations that may be used during the exposure exercises.

After each session, the patients of the two groups carried out tasks in order to apply the principles developed and experimented during the VRT or CBT sessions. The purpose of these tasks is to practice *in vivo* what was experienced in dummy situations (in the virtual world, or in the therapeutic group), and to facilitate the cognitive behavioral learning process.

7.5 Outcome

We present here results, comparing 18 patients of CBT group to 18 patients of VRT group, after treatment and complete evaluation. All the means and standard deviations for the assessments scores, respectively for the global population and comparing the two therapeutic groups are presented in two tables (Table 2 and Table 3).

Table 2. Mean, standard deviation and evolution LSAS, HAD, BECK-13, Rathus, TAPIS, Sheehan, CGI and Social Contexts inducing Anxiety scores before and after treatment (general population)

	N=36 **17 males / 19 females** **Age = 31,6 (8,3)**		
Duration of the disorders	**15,7 years (9,8)**		
	Pre	**Post**	**Delta**
LSAS			
• Anxiety	46,3 (11,12)	27,2 (11,4)	-19,1
• Avoidance	37,5 (13,2)	18,5 (11,8)	-19
• Total	83,9 (23,5)	45,5 (22,4)	-38,4
HAD			
• Anxiety	10,3 (3,9)	8,4 (3,3)	-1,9
• Depression	5,7 (3,2)	3,7 (4,2)	-2
Beck – 13	5,5 (2,9)	3,5 (2,6)	-2
Rathus	-27,3 (22,9)	-10,8 (26,9)	16,5
Tapis (SISST)			
• Thoughts +	36 (6,7)	43,1 (6,4)	7,1
• Thoughts –	52,9 (8,3)	41,3 (10,1)	-11,6
• Total	-16,8 (9,8)	3,6 (19,5)	20,4
Sheehan			
• Family	4,6 (2,3)	2,8 (1,5)	-1,8
• Social	7,2 (1,5)	3,9 (1,4)	-3,3
• Professional	6,1 (2,6)	3 (2,1)	-3,1
CGI			
• Gravity	4,8 (0,7)	3 (1)	-1,8
• Improvement	0	2 (0,7)	2
CGI			
• Improvement by the patient	0	2,2 (0,6)	2,2
Social Contexts inducing Anxiety			
• Performance	2,5 (0,5)	1,3 (0,5)	-1,2
• Intimacy	1,8 (0,5)	0,9 (0,4)	-0,9
• Assertiveness	2 (0,7)	1,2 (0,7)	-0,8
• Scrutiny	1,8 (0,4)	1 (0,4)	-0,8
• Total	8,2 (1,3)	4,5 (1,4)	-3,7

Table 3. Mean, standard deviation and evolution LSAS, HAD, BECK-13, Rathus, TAPIS, Sheehan, CGI and Social Contexts inducing Anxiety scores before and after treatment (CBT and VRT groups)

	CBT group (n=18) 9 males / 9 females Age = 32			**VRT group (n=18) 8 males / 10 females Age = 30,5**		
Duration of the disorders	**16,4 years (12,2)**			**14,5 years (6,8)**		
	Pre	**Post**	**Delta**	**Pre**	**Post**	**Delta**
LSAS						
• Anxiety	43,7 (13)	26,5 (13,1)	-17,2	48,9 (8,3)	27,9	-21
• Avoidance	34,3(13)	17,1 (12,5)	-17,2	40,7 (12,9)	(9,7)	-20,8
• Total	78 (25,2)	43,5 (24,6)	-34,5	89,7 (20,6)	19,9 (11,2) 47,6 (20,4)	-42,1
HAD						
• Anxiety	11,8(3,8)	9,3 (3,7)	-2,5	8,9 (3,7)	7,6 (2,7)	-1,3
• Depression	6,2 (3,2)	3,9 (4,6)	-2,3	5,1 (3,2)	3,3 (3,9)	-1,8
Beck – 13	6,3 (2,9)	3,7 (2,9)	-2,6	4,7 (2,8)	3,3 (2,3)	-1,4
Rathus	-26,9 (21,4)	-5,9 (27)	21	-27,8 (25)	-15,7 (26,6)	12,1
Tapis (SISST)						
• Thoughts +	34,7 (7,2)	42,6 (7,3)	7,9	37,3 (6)	43,6	6,3
• Thoughts –	54,1 (9,9)	41,1 (11,8)	-13	51,7 (6,3)	(5,6)	-10,2
• Total	-19,3 (11,4)	5,2 (25,4)	24,5	-14,3 (7,3)	41,5 (8,2) 2,1 (11,4)	14,8
Sheehan						
• Family	4,9 (2,4)	2,7 (1,8)	-2,2	4,4 (2,2)	3 (1)	-1,4
• Social	7 (1,9)	3,9 (1,8)	-3,1	7,4 (0,9)	4 (0,9)	-3,4
• Professional	6,2 (2,7)	3,2 (2,3)	-3	5,9 (2,5)	2,8 (1,9)	-3,1
CGI						
• Gravity	4,7 (0,8)	3,1 (1,2)	-1,6	4,8 (0,7)	2,8 (0,6)	-2
• Improvement	0	2 (0,9)	2	0	2 (0,5)	2
CGI						
• Improvement by the patient	0	2,3 (0,7)	2,3	0	2,1 (0 ,4)	2,1
Social Contexts inducing Anxiety						
• Performance	2,4 (0,5)	1,1 (0,6)	-1,3	2,6 (0,4)	1,4 (0,5)	-1,2
• Intimacy	1,9 (0,6)	1 (0,5)	-0,9	1,7 (0,4)	0,8 (0,3)	-0,9
• Assertiveness	1,8 (0,7)	1 (0,7)	-0,8	2,1 (0,7)	1,5 (0,6)	-0,6
• scrutiny	1,9 (0,4)	1 (0,5)	-0,9	1,7 (0,4)	0,9 (0,2)	-0,8
• Total	8,1 (1,3)	4,2 (1,7)	-3,9	8,3 (1,3)	4,7 (1,2)	-3,6

7.5.1 Principal criterion

The level of social phobia of our population, evaluated by the Liebowitz's scale, is considerably reduced, passing from 83,9 to 45,5 (-38,4 points). The two groups know this same improvement. The CBT group passes from 78 to 43,5 (-34,5 points) and the VRT group from 89,7 to 47,6 (-42,1 points).

The two subscores of the Liebowitz's scale know the same positive evolution.

Anxiety subscore in our population varies from 46,3 to 27,3 (-19,1 points) points while avoidance subscore varies from 37,5 to 18,5 (-19). For VRT group, anxiety subscore varies from 48,9 to 27,9 (-21 points) points while avoidance subscore varies from 40,7 to

20,8). For CBT group, anxiety subscore varies from 43,7 to 26,5 (-17,2 points) points while avoidance subscore varies from 34,3 to 17,1 (-17,2).

7.5.2 Secondary criteria

- **Social Anxiety Components**

The progress of the assertiveness level, evaluated with the Rathus scale, is favorable for the whole population (evolution of +16,5 from -27,3 to -10,8): improvement of the CBT group patients (evolution of +21, from -26,9 to 5,9) is a little better than improvement of the VRT group patients (evolution of +11,9, from -27,8 to -15,6).
The evaluation of the social contexts inducing anxiety shows a clear and identical improvement for the two groups: the total score passes from 8,1 to 4,2 for the CBT group patients (-3,9) and from 8,3 to 4,7 for the VRT group patients (-3,6). The improvement of the two groups is very similar in the sub-scores of performance (CBT: -1,2 and VRT: -1,3), intimacy (VRT and CBT : -0,9), assertiveness (CBT: -0,8 and VRT : -0,6) and scrutiny (CBT: -0,9 and VRT: -0,8).

- **Anxiety level**

Anxiety level evaluated by the sub-score of HAD scale shows a slightly higher improvement for the CBT group patients, varying from 11,8 to 9,3 (-2,5) compared to the VRT group patients, varying from 8,9 to 7,6 (-1,3).

- **Depression level**

The general level of depression of our population, measured with the BDI-13 scale, evolves a little, passing from 5,5 to 3,5 (-2). This evolution is of -2,6 for CBT group (from 6,3 to 3,7) and of -1,4 for VRT group (from 4,7 to 3,3).
The depression subscore of the HAD for the whole population varies from 5,7 to 3,7 (-2 points). This evolution is of -2,3 for CBT group (from 6,2 to 3,9) and of -1,8 for VRT group (from 5,1 to 3,3).

- **Handicap**

Improvement of the handicap, evaluated by the Sheehan's scale, is similar for the two groups. We notice: a social handicap decrease of 3,3 points for the global population (from 7,2 to 3,9), of 3,1 points for the CBT group patients (from 7 to 3,9) and of 3,4 points for the VRT group patients (from 7,4 to 4); a professional handicap decrease of 3,1 points for the global population (from 6,1 to 3), of 3 points for the CBT group patients (from 6,2 to 3,2) and of 3,1 points for the VRT group patients (from 5,9 to 2,8); and finally a family handicap decrease of 1,8 points for the global population (from 4,6 to 2,8), of 2,2 points for the CBT group patients (from 4,9 to 2,7) and of 1,4 points for the VRT group patients (from 4,4 to 3).

- **CGI**

According to the evaluation clinically carried out with the two CGI scales, we notice a regression of the gravity of the illness of 1,8 points for the global population (from 4,8 to 3), of 1,6 points for the CBT group patients (from 4,7 to 3,1) and of 2 points for the VRT group patients (from 4,8 to 2,8). Clinical therapist evaluation of the improvement for the whole population is rated to 2, this score being identical for the patients of CBT group and the patients of VRT group.
Patient evaluation of her/his disease improvement is rated to 2,2 for the general population, to 2,3 for the CBT group patients and to 2,1 for the VRT group patients.

7.5.3 Discussion

According to the methodology retained for this study, a statistical analysis of the results was not available, and this, for several reasons:

- No randomization of the patients has been realized. A randomization was impossible within the framework of this study for several practical reasons related to the characteristics of the two types of therapy. The organization of CBT groups is done according to an established calendar scheduled in advance and the patients are included in these groups at the beginning of each program, in other words, two times per year. In the VRT group, we only included patients having some abilities to use a computer or the interfaces.

- Patients number (18 in each therapeutic group) was not enough to give a statistical significativity to the obtained results. By retaining the score obtained on the Liebowitz Social Anxiety Scale (LSAS) as the main criteria for the statistical analysis of the results, and according to the evolution of this scale during the therapy, we should have included 90 patients in each group to statistically exploit the collected data.
  In addition, evaluations have only been carried out "before" and "after" treatment. Follow-up evaluations (6 months after the end of the treatment)) are in progress and are not presented in this study.

However a clinical analysis of the results can be clearly made. It reveals several significant points:

- We included in the study patients showing high levels of social phobia, and not having a simple light or average social anxiety.

- According to the principal criterion, that is LSAS total score, but also anxiety and avoidance LSAS sub-scores, patient's improvement is approximately the same in the two groups, VRT and CBT. At first the two populations did not seem perfectly homogeneous in term of inclusion. Patients of the VRT group seemed to be more socially anxious than those of the CBT group. However, the positive results observed for VRT group, slightly higher than those of the CBT group, are very interesting, insofar as patients of VRT group were more severely social phobics than those of CBT group.

- For the secondary criteria, all in all, VRT patients show the same improvement as CBT patients. It is thus the case for the SISST, the Rathus scale or the Questionnaire of Social Contexts inducing Anxiety, even if the improvement seems a little better for the patients of CBT group.

- The weak variations of depression assessment, observed before and after treatment, does not have much value, insofar as these evolutions are weak and that, at the beginning, the depression levels were very weak.

- Patients handicap evaluation in the three fields (family, social and professional) shows a favorable evolution that is completely clinically comparable for the two groups.

- The same observation can be made with CGI measurements (improvement, gravity) where, all in all the two groups positively evolve in a very similar way.

Regarding the therapeutic care of the VRT group patients, we found a good observance of the treatment. The patients came to all the sessions. According to our clinical experience with social phobics, we usually notice that patients often miss some sessions, which was not the case here with the VRT group. The patients underlined the "playful" aspect of the therapy, which may probably and partially explain this good observance. The patients reacted to the virtual environments in a way similar to that of their *in vivo* experiments.

When they were facing the feared virtual situations, they felt discomfort, anxiety or shame. Physiological manifestations appeared, such as blushing. We can suppose that an improvement of the quality of the virtual worlds could increase this impression of realism and presence during the virtual exposure sessions. VRT allowed the therapist to control the exposure to stimuli inducing anxiety (e.g. variations of the stress situations, addition of new sources of stimuli, etc.) better than in the *in vivo* exposure sessions.

Despite these good results among patients having followed the virtual reality treatment, we must be very careful in the results interpretation (but it's also the case for the patients having followed the traditional CBT). Many therapeutic components go along with the used treatment process. There is certainly the regular and repeated exposure to the virtual environments, but there is also the presence of the therapist who guides the patient and works with him/her in order to modify her/his behavioral and cognitive reactions.

Moreover, the patients of the two groups have carried out some tasks between their therapeutic sessions, in order to apply the principles developed and experimented during the sessions. For these reasons, it is difficult to conclude which of all these ingredients explains the improvement of the patients.

8. Conclusion

The main goal of Vepsy Updated was to prove the technical and clinical viability of using portable and shared Virtual Reality systems in clinical psychology. One of the selected disorders was Social Phobia, an anxiety disorder that has long been ignored and that is, since fifteen years, the object of an intensive research.

We defined a very precise clinical protocol and selected four exposure situations dealing with anxiety tied to assertiveness, performance, intimacy, and scrutiny. Each one corresponds to a special recognized case of social anxiety and its purpose is to reduce the patient's unease in the corresponding real situations. The objective is to teach the patient new behaviors.

We sketched four scenarios fitting the cognitive behavioral therapy and then we created four virtual environments with the corresponding characters and sounds. A fifth virtual environment was designed without characters, in which the patient learns how to use the tools and how to navigate in a virtual world.

We observed from the results of our small-scale clinical trial and previous studies that the patients reacted to the virtual environments in a way similar to that of their *in vivo* experiments in most cases. They are sensitive to the environments and react consistently with their problem. When they are facing the feared situation, they feel discomfort, or anxiety, or shame. Blushing and other physical feelings may appear.

In the large-scale clinical trial, we carried out a pilot study comparing a virtual reality therapy with a cognitive-behavioral therapy for social phobics patient. To our knowledge, it is the first study including patients suffering from a severe social phobia (and not a simple isolated fear to speak in public) and based on varied social environments,

corresponding to the various forms of social anxiety (and not only on the public environment). Even if the format of this study has not allowed a statistical analysis of the results, we noted in the two groups of treatment a significant clinical improvement.

According to the principal criterion, the patients of VRT group, initially the most anxious, showed a more significant reduction of their social anxiety than the patients of CBT group. Clinically improvement is similar for the two groups with regard to the other psychometrics criteria.

These encouraging results agree entirely with the published studies related to the treatment of phobic disorders by virtual reality. However it will be necessary to lead other studies to conclude about the efficacy of VRT in social phobia, by carrying out a randomization of the patients, by including a sufficient number of patients to allow a statistical analysis and by carrying out follow-up evaluations of the treatments.

The Social Phobia Module could be improved and expanded. Here are some development directions we suggest:

- Improve the designed worlds and extend the virtual worlds to other social situations;
- Introduce richer avatar behaviors
- Introduce some other techniques, like video
- Improve the management of the patient's database and follow-up, and its user-interface.
- The trials have been done with a virtual protocol only. A further investigation could consider its integration in the traditional cognitive behavioral treatment.

As a summary of our achievements so far, the design of the protocol to address social phobia troubles involved the contribution of psychologists/psychiatrists, computer scientists, and graphic artists. We implemented it in close collaboration and with a constant feedback between the members of the teams. We tested it and reported our preliminary results through conference communications. Our provisional conclusion is that virtual environments are likely to be efficient in the treatment of social phobia.

Following our demonstrations and communications, we received demands from medical teams to replicate our approach and to build specific environments for other diseases. These teams would like to use the methods we designed or to adapt the virtual worlds to Parkinson disease, multiple sclerosis, or aging. We take it as a very rewarding appreciation that opens significant perspectives to Vepsy.

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7 The use of VR in the treatment of Eating Disorders

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Abstract. In the treatment of eating disorders, the cognitive behavioral therapy (CBT) is still considered the best approach but could present different limitations related to costs of behavioural procedures (such as exposure and desensitization) or difficulty of cognitive techniques (such as imagination of daily scenarios). The major aim of this contribution is the description of a new Virtual Reality-enhanced treatment named Experiential Cognitive Therapy (ECT). Rationale and protocols about this new approach are explained. Moreover data about clinical trials, carried on with the VEPSY Project, are shown comparing different groups: experimental group (ECT), cognitive-behavioural therapy group (CBT), nutritional group and control group.

1. Introduction

In the past decade medical applications of virtual reality (VR) technology have been rapidly developing, and the technology has changed from a research curiosity to a commercially and clinically important area of medical informatics technology [1]. As noted by Szekely and Satava [1] "Computer modelling and simulation have become increasingly important in many scientific and technological disciplines owing to the wealth of computational power... Likewise, the development of techniques for acquiring data (for example, medical imaging) has enabled the easy generation of high resolution copies of real world objects from the computer's memory. The development of imaging technologies, such as magnetic resonance imaging, computed tomography, and ultrasound, has made the acquisition of highly detailed anatomical and partially functional models of three dimensional human anatomy a routine component of daily clinical practice" (p. 1305).

This lead to an increasing number of VR applications in medicine [2, 3]. Virtual Environments (VEs) for health care are being developed in the following areas: surgical procedures (remote surgery or telepresence [4, 5], augmented or enhanced surgery [6, 7], and planning and simulation of procedures before surgery) [8, 9]; medical therapy [10-15]; preventive medicine and patient education [16]; medical education and training [17, 18];

visualization of massive medical databases [19]; skill enhancement and rehabilitation [20]; and architectural design for health-care facilities [21].

However, there is a growing recognition that VR can play an important role in clinical psychology, too [22]. One of the main advantages of a virtual environment for clinical psychologists is that it can be used in a medical facility, thus avoiding the need to venture into public situations. Infact, in most of the previous studies, VEs are used to simulate the real world and to assure the researcher full control of all the parameters implied. VR constitutes a highly flexible tool which makes it possible to programme an enormous variety of procedures of intervention on psychological distress. The possibility of structuring a large amount of controlled stimuli and, simultaneously, of monitoring the possible responses generated by the user of the programme offers a considerable increase in the likelihood of therapeutic effectiveness, as compared to traditional procedures [23].

The possibilities offered by VR to clinicians are now improved by the diffusion of the Internet. Since the development of methods of electronic communication, clinicians have been using information and communication technologies for the exchange of health-related information. However, the emergence of new shared media, such as the Internet and virtual reality are changing the ways in which people relate, communicate, and live.

Health care is one of the areas that could be most dramatically reshaped by these new technologies. Distributed communication media could become a significant enabler of consumer health initiatives. In fact, they provide an increasingly accessible communication channel for a growing part of the population. Moreover, in comparison with traditional communication technologies, shared media offer greater interactivity and better tailoring of information to individual needs.

E-health, the integration of and telehealth technologies with the Internet and shared virtual reality is the next logical step. Although e-health is a branch of telehealth, it is differentiated in several important ways. As noted by Allen [24] telehealth to date has been largely non-Internet based and has been characterized by point-to-point (e.g., T1) and dial-up (e.g., telephone, ISDN) information exchange. E-health, on the other hand, is more accessible because of its increasingly affordable ability to communicate through a common set of standards and across operating systems.

This Section presents a promising combined use of VEs and telemedicine in the assessment and treatment of eating disorders [25-29]. Specifically it describes the characteristics of the Experiential Cognitive Therapy (ECT) - a VR and telemedicine based treatment to be used in eating disorders' assessment and treatment - by systematic analysis of its rationale and different phases.

2. Cognitive Behavioral Therapy in Eating Disorders: some challenges for the future

Cognitive-behavioral therapy (CBT) for eating disorders can be described as "a symptom-oriented approach that focuses on the beliefs, values, and cognitive processes that maintain the eating disordered behavior" [30, p. 436]. This approach is based on the theory that certain cognitive characteristics such as low self-esteem, distorted beliefs about the "meaning" of weight, shape, and appearance, dichotomous logic and perfectionism lead to an over concern about one's body size [31, 32]. This preoccupation leads to the use of compensatory behaviors, such as self-induced vomiting, fasting, excessive exercise and abuse of diuretics or laxatives [33].

The widespread use of CBT derives directly from Fairburn's publication of a detailed treatment manual for the treatment of Bulimia Nervosa [34, 35]. As described by Fairburn and Cooper [36], CBT consists of 19 sessions of individual treatment lasting about 20 weeks. The treatment has three stages. The phase one incorporates the use of

psycho-educational principles and behavioral techniques designed to disrupt the cycle of binge eating and purging and help the individual normalize their eating patterns. Self-monitoring, through the use of daily food journals, is firmly established during this phase of treatment. In phase two, cognitive restructuring and problem solving are used to help the individual identify and challenge distorted thoughts, beliefs, and values that are maintaining the eating disorder. Interpersonal and environmental stressors that trigger bulimic episodes are explored and alternative methods of coping are identified. The final phase of treatment focuses on relapse prevention strategies and the maintenance of progress.

In the cognitive-behavioral approach to the treatment of anorexia nervosa, the therapist focuses on using cognitive restructuring to change distorted beliefs and attitudes [31]. Targets of the treatment are the "meaning" of weight, shape and appearance, which are believed to underlie dieting and fear of weight gain [37]. Recovery from anorexia nervosa is achieved by coupling the use of specific behavioral techniques, which address the normalization of eating patterns and weight restoration (e.g., the use of food diaries, meal plans incremental weight gain), with the use of cognitive techniques (e.g., cognitive restructuring, problem solving, identification and expression of affect), designed to improve self-esteem and develop a sense of personal effectiveness [30].

However, as noted by Mizes [38], some aspects of the actual practice guidelines for CBT "...are based on a combination of research-based recommendations and clinical consensus because of significant gaps in the extant research" (p. 387). In particular there are at least four themes that are somehow neglected by current guidelines for eating disorders: body experience disturbances [39, 40], self efficacy and motivation for change [41], interpersonal relationships [42-44] and the integration between all the different professional figures involved in the treatment [45].

Even if all these themes are widely discussed in literature, the recommended clinical practice for them are more based on "expert consensus" than on scientific data. Infact, little empirical work has been done to point out the content of clinical guidelines and to validate their efficacy in treatment.

It is well known that few eating disordered patients are not over concerned with their physical body [46]. It is also known that for most patients, changing the body experience is the hardest part of their recovery [47]. However, standard eating disorder programs provide less therapy and have a smaller treatment effect for body image compared with eating behavior [40, 48].

The same happens when clinicians have to face the lack of motivation for change.

The denial of the disorder and resistance to treatment are two of the most vexing clinical problems in these pathologies [41]. Given the importance of managing resistance for successful treatment, it is surprising that so little research has been done in this area [38].

Moreover, clinical observations of eating disordered patients have described their difficulty engaging in and deriving gratification from non-food-related activities. Following this point Lehman and Rodin [49] suggest that food can be viewed as a primary source of psychological nurturance by these individuals: they use food to compensate for their inability to get gratification from non-food-related activities. As recently found in a research by Cooley and Toray [50] symptoms of eating pathology were associated with figure dissatisfaction, ineffectiveness, self-efficacy to control eating when experiencing negative feelings, and reward conditions.

It is also well known that the other widespread approaches to the treatment of eating disorders - Interpersonal Therapy, Psychodynamic approach and Family Therapy – have their focus on the patient's interpersonal relationships [42-44]. The stated rationale of Interpersonal Therapy was that the eating disorder occurs as a response to interpersonal

disturbances (e.g., social isolation, fears of rejection) and consequent negative moods. So, the treatment aims at encouraging mastery of current social roles and adaptation to interpersonal situations.

Moreover, according to psychodynamic and family systems theorists an eating disorder can be considered a reflection or symptom of a deeper, more pervasive problem in the family's role structure, affective expression, relationship dynamic, and style of interacting [51-53]]. As a result, the anorexic or bulimic child has difficulty separating from the family and consolidating an individual identity.

However, standard CBT therapy is more focused on addressing food related cognitions and behaviors than on the development of an empowerment process producing enhanced feelings of self-efficacy, perceived competence and a better approach to interpersonal situations.

Finally, based on current knowledge, a comprehensive program involving different approaches is likely to be needed for obtaining and maintaining results in therapy [54].

3. A new VR and Telemedicine based approach: Experiential Cognitive Therapy

For many years, research and practice in eating disorders and weight management have been based largely on a unidimensional, simplistic, weight-loss/weight-gain paradigm because of the common assumption that the major cause of obesity is overeating [55]. In spite of this widespread assumption, however, a review of the literature does not support the notion that fat individuals consume more calories than their lean counterparts. A review of 20 studies by Wooley and colleagues [56] and the findings of two more reviews [57, 58] suggest that, generally, fat people probably do not consume more calories than people who are not overweight. Thus, if fat people do not necessarily eat any more than thinner people, the prescription of a diet may not be warranted or reasonable. This is probably why the long-term success rate for persons using this paradigm has been low [59]. Moreover, more recent follow-up studies after a weight-loss intervention have shown how frequent dieters usually have significantly more weight regain than less frequent dieters [60, 61].

To overcome this unsuccessful approach, our work follows some new thinking in this area of weight and eating disorders treatment [62, 63] that recognizes the dangers of chronic dieting and proposes a focus on body image, motivation for change, self-efficacy, self-acceptance and better nutrition. Specifically our program stresses the following: (a) understanding the origins and reinforcement of negative attitudes toward body image; (b) redefining beauty with regard to fatness and thinness; (c) examining, treating, and decreasing the restriction in activities and negative feelings many eating disordered patients experience; (d) teaching clients empowerment techniques to support motivation to change and self-efficacy, and (e) developing individualized treatment plans regarding eating behaviors and exercise. We hypothesize that the proposed approach would be effective in increasing the number and variety of clients' daily activities, decreasing their fat phobic attitudes and depression, and increasing their self-esteem.

Experiential-Cognitive Therapy for eating disorders is a relatively short-term, integrated, patient oriented approach that focuses on individual discovery [64]. The treatment lasts about 28 weeks - 4-week inpatient/outpatient treatment and 24-week telemedicine (Internet based) treatment - and it is administered by therapists having a cognitive-behavioral orientation who work in conjunction with a psychiatrist as far as the pharmacological component is concerned.

When a multidisciplinary treatment is mandatory (e.g., a suicidal patient), Experiential CT is conducted on an inpatient basis. However, Experiential CT can be profitably applied also to non hospitalized patients. In this case the treatment has to include

nutritional counselling and physical activity to help patients learn to regulate their eating and cope with specific high-risk situations (i.e., increased availability of food or limited control) that cannot be adequately addressed during outpatient therapy.

During the first phase (see Table 1), the different therapists carry out one *step* of the psychological process, both with individual and group sessions. The individual work regards assessment by means of psychometric tests, weekly supportive psychological talks, sessions for assessment and therapy carried out using Virtual Reality (VR), and psychopharmacological assessment and control. The psychological group therapy is based on weekly group meetings ("closed" group of 5/6 persons) of two hours each. The work group

Table 1. Experiential-Cognitive Treatment: In-Patient/Out-patient Phase

FIRST WEEK	
PSYCHOMETRIC TEST (test)	
PSYCHODIAGNOSTIC INTERVIEW	PRELIMINARY GROUP (motivation to treatment and definition of rehabilitative protocol)
SESSION 1 VR ASSESSMENT + BODY IMAGE (Virtual balance + sitting room)	NUTRITIONAL ASSESSMENT
SECOND WEEK	
SESSION 2 VR EATING CONTROL + INTERPERSONAL REFRAME (Kitchen + bathroom + bedroom)	NUTRITIONAL GROUP (2/3 sessions)
SESSION 3 VR BODY IMAGE (BIVRS)	PSYCHOLOGICAL GROUP (1 session)
SESSION 4 VR EATING CONTROL (Supermarket)	PHYSICAL ACTIVITY
THIRD WEEK	
SESSION 5 VR BODY IMAGE + INTERPERSONAL REFRAME (Gymnasium)	NUTRITIONAL GROUP (2/3sessions)
SESSION 6 VR EATING CONTROL+ INTERPERSONAL REFRAME (Pub)	PSYCHOLOGICAL GROUP (1 session)
SESSION 7 VR BODY IMAGE+ INTERPERSONAL REFRAME (Clothes shop)	PHYSICAL ACTIVITY
FOURTH WEEK	
SESSION 8 VR EATING CONTROL+ INTERPERSONAL REFRAME (Restaurant)	
SESSION 9 VR BODY IMAGE + INTERPERSONAL REFRAME (Swimming pool + beach)	PSYCHOLOGICAL GROUP (1 session)
SESSION 10 VR EATING CONTROL + BODY IMAGE (Kitchen + BIVRS + 9 doors room)	PHYSICAL ACTIVITY
	FINAL GROUP (motivation to out-patient phase)
PSYCHOMETRIC TESTS (Re-test)	

aims both at training for development and acquisition of assertive skills, and at training for assessment and consolidation of motivation.

Moreover, during the first phase of the treatment the subjects participate to both bi-weekly psycho-nutritional groups held by nutritionists and to daily group sessions of physical activity. The provided physical activities are:

- Postural gymnastics (in the gymnasium), based on:
- Warm-up
- Abdominal exercises, floor exercises, stretching, agility iter, etc. (60 minutes).
- Aerobic activity through the use of cycloergometers (30 minutes).
- Walks in the open with different levels of difficulty (30 minutes).

During the telemedicine phase (see Table 2) the patient has periodical individual contacts - through text, audio or video chat depending on the technologies at patient's disposal - with the therapist who followed him/her during the inpatient/outpatient stage. These contacts will be fortnightly during the first two months and monthly during the third and fourth months. Six month after dismission, there will be a final individual face-to-face session held in our day-hospital. Each patients is also given the possibly of contacting the therapist by e-mail in case of urgencies or emergencies for a maximum of two added contacts each month. The therapist decides, according to the characteristics of the request, the most suitable modality of response among e-mail, chat or telephone. The family of the patient, too, can have a monthly contact by e-mail with the therapist.

During the telemedicine phase are also scheduled six monthly group meetings based on 1-hour text based chat sessions. The groups are composed by the same patients who took part in the group sessions of the inpatient/outpatient phase. In this way the patients already know each other and can discuss with the therapist both on pre-defined subjects concerning assertiveness, self esteem, motivation to change, prevention of relapses, and on other specific individual problems faced during this phase. The patients are also allowed to keep in touch after the group sessions. This reciprocal support (self-help group) can be very useful expecially in the early phases of the outpatient stage: they can feel stronger and less alone in facing the difficulties and the problems of daily life.

Finally, during the telemedicine phase, the patients have to download from Internet at monthly intervals specific text based (booklets) or video based (educational videos) material to be used both for exercises and for the preparation of the individual and group sessions. The topics discussed include assertiveness, self-esteem, body image disturbances, motivation to change and prevention of relapses.

Probably the key novelty of this approach is the use of VR and telemedicine sessions in therapy. [64]. As we have seen in the Introduction, VR is widely used in the treatment of phobias [65-69]. However, it seems likely that VR can be more that a tool to provide exposure and desensitization [70]. As noted by Glantz *et al.*, "VR technology may create enough capabilities to profound influence the shape of therapy" [71, p.92]. In particular, they expect that VR may enhance cognitive therapy. VR can in fact be described as a "cognitive technology", a technology created to influence cognitive operations [72].

Also, the emergence of e-health could have a strong effect on health care. As we have seen, the key characteristic of e-health is the use of shared media. Using the Internet, therapists can present, from a remote site, a wide variety of stimuli and to measure and monitor a wide variety of responses made by the user.

Recently, some researchers have tried to use telehealth in the treatment of eating disorders. Particularly, an American group examined *Student Bodies*, an Internet-delivered computer-assisted health education program designed to improve body satisfaction and reduce weight/shape concerns [73-75]. In a controlled study they evaluated whether an 8-

week program offered over the Internet was able to target body image dissatisfaction, disordered eating patterns, and preoccupation with shape/weight among women at high risk for developing an eating disorder. The results suggest that technological interventions may be helpful for reducing disordered eating patterns and cognitions among high-risk women [75].

Moreover, the findings of the next research coming from the same group showed that an Internet intervention with limited face-to-face contact was more effective in improving body image and reducing disordered attitudes and behaviors than a purely face-to-face psychoeducational intervention [73].

As we have just seen, there are different key topics that are neglected by current CBT guidelines: body experience disturbances, motivation for change, empowerment and the integration between all the different professional figures involved in the treatment. We think that VR and telemedicine have enough capabilities to profound influence the shape of therapy by offering new approaches that can match the topics discussed above. In the next paragraphs is detailed the rationale for such assumption.

3.1 VR and body experience

It is no secret that thinness and fitness are in fashion. During the past few decades, Americans have plunged headlong into the pursuit of losing weight to fit an ideal body image [55]. Nevertheless, body-image disturbance and its link with eating behaviors are still two poorly understood and controversial phenomena. Some researchers have asserted that the disturbance should be considered as a key feature of the eating disorders [76].

However, other authors strongly disagree: Hsu and Sobkiewicz [77] have suggested that it may be time for the concept to be abandoned as an etiological determinant of eating disorders.

Probably this current state of controversy is due, in large part, to problems with the way body image has been conceptualised and studied [78]. As underlined by Thompson [79] the construct of body image has been used to describe various phenomena that vary widely in their specific characteristics. Moreover, the frequent study of only one aspect of body image, implicitly assuming that the disturbance is unidimensional, has hindered the advancement of knowledge in this area [80]. Actually, researchers are studying body-image as a multidimensional phenomenon composed by perceptual and affective dimensions [54, 81], the former referring to apparent perceptual overestimation and the latter referring to the feelings an individual has about his or her body.

Current studies have also underlined the existence of some form of connection between body image and eating behavior. It is well known that few eating disordered patients are not over concerned with their physical body [46]. It is also known that for most of them, changing the body experience is the hardest part of their recovery [47]. Cash [82] recently proposed a general model in which the casual processes in the development of body image and eating disturbances are analyzed. The core features of the model are a separation of historical and proximal influences and the link between body image emotions and adjustive, emotion regulating actions [81]. Such actions include avoiding and concealment behaviors, appearance-correcting rituals, social reassurance seeking, and compensatory actions. Cash's model, has received a recent empirical testing: using a series of different confirmatory factor analysis models (LISREL 7) Riva et al. [83] found a significant causal link between body image dissatisfaction and eating restraint. Specifically, both general and specific body site dissatisfaction appear to have a direct influence on eating restraint. These results seem to confirm that the desire to improve body image is a significant motivation to embark on weight reduction attempts [76].

Generally, the disturbances of body image associated with the eating disorders can be conceptualised as a type of *cognitive bias* [84-86]. The essence of this cognitive perspective is that the central psychopathological concerns of an individual bias the manner in which information is processed. Usually, it is presumed that this biased information processing happens automatically. Also, it is generally presumed that the process happens more or less outside the person's awareness unless the person consciously reflects upon his or her thought processes (as in cognitive therapy). Mineka and Sutton [87] have identified four common types of cognitive bias in research related to depression and anxiety disorders: attentional bias, memory bias, judgmental bias, and associative bias. Three of these four types of cognitive bias have been the focus of research related to eating disorders: preoccupation with body size, body dysphoria, and connected problems.

According to Williamson [86], body size overestimation can be considered as a complex judgement bias, strictly linked to attentional and memory biases for body related information: "If information related to body is selectively processed and recalled more easily, it is apparent how the self-schema becomes so highly associated with body-related information... If the memories related to body are also associated with negative emotion, activation of negative emotion should sensitise the person to body-related stimuli causing even greater body size overestimation" (pp.49-50).

In contrast to the great number of publications on body image, only a few papers focus on the treatment of a disturbed body image in eating disorders [54, 79]. Although some general intervention programs for the treatment of anorexia nervosa and bulimia nervosa have included a component that dealt with body image disturbances, in many of these treatments, this aspect of treatment has been virtually ignored. For example, in a review of cognitive-behavioral treatments of bulimia nervosa, Garner, Fairburn, and Davis [88] catalogued 22 treatment components of the 19 available treatment studies. The treatment of body image disturbance was not listed as one of the 22 intervention procedures. Rosen [48] found that the overwhelming majority of studies either did not target body image dysfunction or failed to measure changes following treatment.

There are two different approaches to the treatment of body image disturbances that are actually used from leading researchers and clinicians: cognitive-behavioral and feminist methodologies [81].

Cash and Rosen are the leading figure in the development of cognitive-behavioral strategies for the treatment of body image in eating disorders [48, 76, 89, 90]. Their approach is based on assessment, education, exposure and change of body image. The therapy identifies appearance assumptions, challenges them and modifies self-defeating body image behaviors. Moreover, the approach involves the development of body image enhancement activities used to support relapse prevention and maintenance of changes, and the integration with weight reduction programs [76, 89, 90].

The feminist approach tries to help women to accept and celebrate the body they have [91, 92]. However, feminist therapy generally varies from traditional forms of therapy in number of ways. Feminists believe that traditional therapy perpetuates the central role of man in the form of the doctor-patient relationship [93]. So, this approach places the therapist and client in equitable roles. Moreover, feminist therapists usually include more experiential techniques, such as guided imagery, movement exercises, and art and dance therapy [93, 94]. Other experiential techniques include free-associative writing regarding a problematic body part, stage performance, or psychodrama [93, 95].

Even if both methods are actually used by many therapists, the treatment of body image disturbance is moving "in the area of multicomponent intervention methods" [81, p. 322]. A recent model proposed by Thompson and colleagues [81] underlines the complexity behind the development of body image disturbances. In the proposed model, self-esteem and depression mediate between the three formative influences (peers, parents

and media) and the frequency of comparison and internalization in the development of the disturbance. In this sense this model suggests that "individuals low in self esteem and high in depression are more vulnerable to factors that produce an awareness of appearance pressures and thus are more likely to engage in social comparison and internalization, leading to body dissatisfaction" [81, p. 315].

An interesting possibility that ECT tries to address is the integration of the different methods commonly used in the treatment of body experience disturbances within a virtual environment [96]. In particular ECT integrates the cognitive methods of Countering, Alternative Interpretation, Label Shifting and Deactivating, the behavioural method of Temptation Exposure with Response Prevention and the visual motorial approach (see Table 3) using the virtual environment in the same way as images in the well-known method of guided imagery [97]. According to this method the therapist, after introducing a selected image, encourages the patient to associate to it in pictures, rather than in word, and to give a detailed description of them.

A choice of this type would not only make it possible to evoke latent feelings, but also to use the psycho-physiological effects provoked by the experience for therapeutic purposes [25, 96]. In practically all VR systems the human operator's normal sensorimotor loops are altered by the presence of distortions, time delays and noise [98]. Such alterations that are introduced unintentionally and usually degrade performance, affect body perceptions, too. The somesthetic system has a proprioceptive subsystem that senses the body's internal state, such the position of limbs and joints and the tension of the muscles and tendons. Mismatches between the signals from the proprioceptive system and the external signals of a virtual environment alter body perceptions and can cause discomfort or simulator sickness [99].

It is also well known that key biases can distort perception of the location and orientation of objects and surfaces in virtual environments. While virtual environment interfaces may be argued to be "natural" in principle, there are many features that can disrupt or distort the natural coupling of actual reaching and walking, to create problems of stability and disorientation, lessons that have been well learned in the flight community [100, 101]. Five critical issues relate to gain, time delay order, travel-view decoupling, and field of view [102].

In a recent study, Cioffi [103] analysed these effects and found that, in VR, the self-perception of one's own body undergoes profound changes that are similar to those achieved in the 1960s by many psychologists in their studies of perceptual distortion.

Particularly, about 40% of the subjects felt as if they had "dematerialised" or as if they were without gravity; 44% of the men and 60% of the women claimed not to feel their bodies. Perceptual distortions, leading to a few seconds of instability and a mild sense of confusion, were also observed in the period immediately following the virtual experience.

Such effects, resulting from the reorganisational and reconstructive mechanisms needed to adapt the subjects to the qualitatively distorted world of VR, could be of great help during a therapy aimed at influencing the way the body is experienced [96], because they lead to a greater awareness of the perceptual and sensory/motorial processes associated with them.

As noted by Glantz [71], one of the main reasons it is so difficult to change patients' attitudes towards their body is that change often calls for a prior step - recognizing the distinction between an assumption and a perception: "Until revealed to be fallacious, assumptions constitute the world; they seem like perceptions, and as long as they do, they are resistant to change. We anticipate using VR to help people in distress make the distinction between assumptions and perceptions" (p.96).

This is particularly true for body experience. When a particular event or stimulus violates the information present in the body schema (as happens during a virtual

experience), the information itself becomes accessible at a conscious level [104]. This facilitates the process of change and, through the mediation of the self (which tries to integrate and maintain the consistency of the different representations of the body), also makes it possible to influence body image. In previous studies this approach was tested on non-clinical subjects [25, 27, 39]. The results showed that the virtual experience induced in the subjects a significantly more realistic view of their body.

3.2 VR in supporting motivation for change and empowerment

Eating disorders are some of the most frustrating and recalcitrant forms of psychopathology. This is mostly due to the strong resistance to change that characterises eating disorders patients, mainly anorectic ones. In fact, it has been hypothesized that treatment recidivism and dropout, commonly observed in this population, may be resulting from programmatic attempts to produce symptom reduction in individuals who are not yet ready to change [105]. In this sense, an effective eating disorders program has to deal with the ambivalent and fluctuating motivation to recovery common in these patients.

A framework for conceptualizing readiness for change in treatment-resistant individuals is provided in the transtheoretical model of change [106-108]. According to Prochaska and DiClemente [109] motivation cannot be considered as a trait or personality: motivation is not something one has but rather what one does. According to this approach, change happens along two interrelated dimensions: stage and process [105, 106]:

- *Stage* refers to an individual's readiness status at a particular moment in time, and
- *Process* refers to what an individual is doing to work on the problem and bring about change.

Based on their research with smokers [109], these authors identified five stages of change that people face in replacing problematic behaviour. These stages can be considered predictable and stable subprocesses within the therapeutic process. The five stages are:

- *precontemplation*: being unaware of or unwilling to change symptoms;
- *contemplation*: seriously thinking about change;
- *preparation*: having the intention of changing soon;
- *action*: actively modifying behavior and experiences to overcome a problem, and
- *maintenance*: working to prevent relapse.

Prochaska and DiClemente [107] hypothesize that dropouts occur when "therapists and clients are too far apart in their expectations on which stage of change they will be working" (p. 287). In fact, the problem behaviour doesn't mean the same thing to the client as it does to the therapist. Moreover, two stages of change are particularly critical for therapy: precontemplation and contemplation.

Patients in the precontemplation stage are not even thinking about modifying their behaviour. In fact, they do not believe their eating or restricting is a problem and, usually, take great pride in their level of self discipline. To move the patient to the next stage of change the therapist works with the client to determine if there is another complaint or goal on which the client wishes to work and for which she can become a customer [110]. VR can support the therapist in identifying possible complaints by immersing the patient in real-life situations not directly connected with the eating behaviours. Using the responses of the patients to the situation proposed; the therapist can help them in identifying a salient goals.

Contemplation is a paradoxical stage of change, since the patient is open to the possibility of change but is stopped by ambivalence. The characteristic style of the contemplator is, "yes, but . . .". Two key techniques are usually in facilitating a shift from the contemplation stage to the determination stage of change [110]. The first technique is the use of the *miracle question*, a typical approach used by the solution-focused brief therapy [110, 111].

The miracle question is used to help the client identify how her life would be different if her eating disorder were miraculously gone. The second technique is the *search for exceptions*: situations in which the patient has been able to manage the problematic eating behaviours more successfully. Using VR to experience the effects of the miracle and the successful situations, the patient is more likely not only to gain an awareness of her need to do something to create change but also to experience a greater sense of personal efficacy.

In general, these techniques are used as triggers for a broader empowerment process. In psychological literature *empowerment* is considered a multi-faceted construct reflecting the different dimensions of being psychologically enabled, and is conceived of as a positive additive function of the following three dimensions [112]:

- *perceived competence*: reflects role-mastery, which besides requiring the skilful accomplishment of one or more assigned tasks, also requires successful coping with non-routine role-related situations;
- *perceived control*: includes beliefs about authority, decision-making latitude, availability of resources, autonomy in the scheduling and performance of work, etc;
- *goal internalization*: this dimension captures the energizing property of a worthy cause or exciting vision provided by the organizational leadership.

Virtual reality can be considered the preferred environment for the empowerment process, since it is a special, sheltered setting where patients can start to explore and act without feeling threatened. In this sense the virtual experience is an "empowering environment" that therapy provides for patients. As noted by Botella [113], nothing the patient fear can "really" happen to them in VR. With such assurance, they can freely explore, experiment, feel, live, experience feelings and/or thoughts. VR thus becomes a very useful intermediate step between the therapist and the real world.

Besides, it is unnecessary to wait for situations to happen in the real world because any situation can be modelled in a virtual environment, thus greatly increasing self-training possibilities. In addition, VR allows the situation to be graded so the patient can start at the easiest level and progress to the most difficult. Gradually, because of the knowledge and control afforded by interaction in the virtual world, the patient will be able to face the real world.

Given to its flexibility, VR is an excellent source of information on self-efficacy. In fact, as underlined by Botella and colleagues [113], "different environments can be designed to practically ensure success in all of the patient's virtual adventures; and occasional difficulties, challenges, and failures can be posed for the patient to overcome.

This means that patients are able to discover that difficulties can be defeated. They also have the experience of a competent, effective, empowered self, and can attribute all this personal competence to internal factors: perseverance and effort." (p. 77).

According to Vitousek et al. [41], another well suited approach to face denial and to support the empowerment process is the *Socratic method*. In this method, the therapist uses different questions to help patients synthesize information and to reach conclusions on their own. Usually, the therapist poses hypothetical, inverse, and third-person questions [41]: for example, would the significance of body shape change if anorexic patient became stranded on a desert island? Would a patient swallow a magic potion that could remove her fear of

normal weight? Would a bulimic client exchange her bingeing and purging for a 5- or 10-pound gain?

VR is well suited to this approach, for its ability of immersing the patient in a real-like situation that she/he is forced to face. Infact, the key characteristic of VR is the high level of control of the interaction with the environment without the constraints usually found in real life. VR is highly flexible and programmable. It enables the therapist to present a wide variety of controlled stimuli and to measure and monitor a wide variety of responses made by the user [114]. Both the synthetic environment itself and the manner in which this environment is modified by the user's responses can be tailored to the needs of each client and/or therapeutic application. Moreover, VR is highly immersive and can cause the participant to feel "present" in the virtual rather than real environment. It is also possible for the psychologist to follow the user into the synthesised world.

The advantages of a VR-based Socratic method are clear. It minimizes distortion in self-report, since there is no script for conforming clients to parrot or oppositional clients to reject; a typical behaviour of anorexic individuals.

Moreover, it circumvents power struggles because the therapist can be invisible to the patient and presents no direct arguments to oppose. Finally, evidence is more convincing and conclusions better remembered because they are one's own. As noted by Miller & Rollnick [115] people are "more persuaded by what they hear themselves say than by what other people tell them" (p. 58).

As we have seen before, change often calls for the recognition of the distinction between an assumption and a perception [70]. By using VR, the therapist can actually prove that what looks as a perception doesn't really exist. This gets across the idea that a person can have a false perception. Once this has been understood, individual maladaptive assumptions can then be challenged more easily. In this sense, the use of VR can support the development of a psychologically empowered state [112]: a cognitive state characterized by a sense of perceived control, competence, and goal internalization.

4. The design of a VR and telemedicine system for clinical use

Even starting by the above considerations, understanding how to use immersive virtual reality (VR) to support clinical practice presents a substantial challenge for the designers and users of this emerging technology.

4.1 The design of a VR system for clinical use

As recently noted by Banos et al. [116] VR has two opposite faces. On one side it can be used by clinicians as a "setting lab where to study anomalous behaviors, emotions and beliefs" (p.284). On the other side, "VR can be also seen as a creator of psychopathology" (p. 288) for its potential of inducing reality judgement and identity problems. Moreover, it is well known that this tool can provoke important side effects such as cybersickness and after-effects [117], forcing the clinician to a precise planning of his approach to lessen the probability of inducing harmful consequences for the patients.

These opposite faces are owed to the peculiar characteristics of VR. This tool is not simply a particular collection of technological hardware, but can be considered as a new *medium* defined in terms of its effect on both basic and major psychological processes [118-120]. According to Bricken [121] the essence of VR is the inclusive relationship between the participant and the virtual environment, where direct experience of the immersive environment constitutes communication. In this sense, VR can be considered as the leading edge of a general evolution of present communication interfaces like television,

computer and telephone [122]. Main characteristic of this evolution is the full immersion of the human sensorimotor channels into a vivid and global communication experience [123].

Following this approach, it is also possible to define VR in terms of human experience [124]: "a real or simulated environment in which a perceiver experiences telepresence", where telepresence can be described as the "experience of presence in an environment by means of a communication medium" (pp.78-80).

As noted by Banos et al. [116], through the experience of telepresence VR can affect cognitive development for "its capability of reducing the distinction between the computer's reality and the conventional reality". Moreover "VR can be used for experiencing different identities and... even other forms of self, as well" (p. 289). As Mantovani [125] notes, "Virtual reality is a communication environment in which the interlocutor is increasingly convincing in terms of physical appearance, yet increasingly less tangible and plausible in terms of personal identity. This paradox results from juxtaposing a convincing simulation of the physical presence of the other, and the disappearance of the interlocutor's face behind a mask of false identities" (p.197). It is surely no accident that members of electronic communities very often adopt false 'nickname' identities, and openly accept them in others.

According to Vincelli [23, 126] this situation produces a change with respect to the traditional relationship between client and therapist. The new configuration of this relationship is based on the awareness of being more skilled in the difficult operations of recovery of past experiences, through the memory, and of foreseeing of future experiences, through the imagination. At the same time, the subject undergoing treatment perceives the advantage of being able to re-create and use a real experiential world within the walls of the clinical office of his own therapist. However, this is possible only if the virtual environment is able to support the relationship between the clinician and the patient.

Following the suggestions and feedbacks of the therapist, the patient is not simply an external observer of pictures or one who passively experiences the reality created by the computer, but on the contrary may actively change the three-dimensional world in which he is acting, in a condition of complete sensorial immersion.

This approach shifts the focus of our attention in creating successfully clinical virtual environments. Faithfulness in reproducing the physical characteristics of the "real" environment is not necessarily the only thing to be borne in mind in simulation: the possibility of interaction which virtual environments allow is also important. More than the richness of available images [127, 128], the sensation of presence depends on the level of interaction/interactivity which actors have in both "real" and simulated environments [129, 130]. Human action needs a certain amount of freedom of movement to adapt itself smoothly to the needs of a changing environment, which is why a good clinical VR system must grant a certain amount of freedom of movement to the patient who moves in it. As noted by Ellis [131] the key questions for a VR designer are: "Can the users accomplish the tasks they accept? Can they acquire the necessary information? Do they have the necessary control authority? Can they correctly sequence their subtasks?" (p.258). In fact, the successful implementation of virtual environment simulations will directly depend on the answers to these types of questions.

The main consequence of this approach for the design and the development of clinical oriented VR systems is that a patient's presence in an environment exists if and only if that patient can use the VR for cooperating with the therapist and/or other patients, and even for entering into conflict with them. In fact, than the richness of available images [127, 128], the sensation of presence depends on the level of interaction/interactivity which actors have in both "real" and simulated environments [129]. In this sense, emphasis shifts from quality of image to freedom of movement, from the graphic perfection of the system to the actions of actors in the environment.

4.2. The design of a telehealth system for clinical use

According to Wootton [132], there are basically two reasons why telehealth is used: "either because there is no alternative, or because it is in some sense better than traditional medicine" (p. 12). In this sense telehealth has been used very successfully for optimizing health services delivery to people who are isolated because of social and physical boundaries and limitations [133, 134]. Nevertheless, the benefits of telehealth, because of the variety of its applications and their uneven development, are not self-evident [135, 136]. In a recent study Currel *et al.* [137] assessed all the randomized trials available in scientific literature to verify the effects of telemedicine as an alternative to face-to-face patient care. Although none of the studies showed any detrimental effects from the interventions, neither did they show unequivocal benefits and the findings did not constitute evidence of the safety of telemedicine.

However, the emergence of e-health is supporting the cost-effectiveness of certain applications [138] such as radiology, prisoner health care, psychiatry, and home health care. Its key advantage is the possibility of share different media and different health care tools in a simple to use and easily accessible interface. A recent Australian study showed that the cost-effectiveness of both telehealth and telemedicine improves largely when they are part of an integrated use of telecommunications and information technology [139]. The conclusion of the author is that it is unwise to promote telehealth in isolation from other uses of technologies in health-care.

Moreover, the research in the area clearly underlines that e-health is not simply a technology but a complex technological and relational process [140]. In this sense, clinicians and health care providers that want to exploit e-health need a significant attention to technology, ergonomics, human factors and organizational changes in the structure of the relevant health service [141].

At this stage, there are different shortcomings that the potential of this approach.

The main problem is non-technical and is connected to the personal and organizational changes needed to introduce e-health in healthcare organizations [142].

Although the introduction of shared media has been successful and become accepted practice in many areas of industry, traditional methods have tended to prevail in health-care. Telehealth and e-health have been adopted by enthusiasts who recognize the potential benefits of a these new media. However, the more widespread introduction of e-health needs considerable organizational change in the way health-care is delivered [143].

This requires an alteration of established factors such as consultations and referral patterns, ways of payment, specialist support for primary healthcare, cooperation between primary and secondary healthcare, defining geographical catchment areas and the "ownership" of the patients [144].

A further problem is the technology of e-health. Actual technology – hardware, software and transmission – is costly and far from perfect [145]. Insufficient image quality, low framing rate, flickering and delays makes working in front of a video terminal unattractive and specifically very tiring. An important effect of this is, among other, an increased tendency to produce errors.

Fortunately, the quality of technology in this area is increasing while costs are falling down. Prices are declining by about 25 per cent per year [146]. Simple telephone-based videoconferencing systems are now available for under $500 while high quality board-based ISDN systems can cost less than $1000. New transmission technologies, including Digital Subscriber Line (xDSL) and cable modem, promise to provide order-of-magnitude increases in dependable bandwidth for a small increment of price. For the success of e-health applications widespread access to the Internet is also required. Many

applications today demand only moderate bandwidth and latency, meaning that standard modem access to the Internet, at 28.8 to 56 kbit/s may suffice.

A recent research studied a low-bandwidth e-health system in eight community hospitals connected to a central hospital via the Internet. PCs were used with videoconferencing software and modem connections to the telephone network. Even if the average live video frame rate was 1 frame/sec. (at the best image quality), with an average latency of 3 seconds, the results suggested that Internet-based videoconferencing is acceptable for certain telemedicine applications [147]. Successful results with a limited bandwidth have also been obtained by an e-health teleconsultation application developed in Croatia: a 33 kbit/s link was established between a team of specialists in the General Hospital 'Sveti Duh' in Zagreb and a general practitioner's clinic in Selca, on the island of Brac using $700 computer systems [148].

Another relevant issue is that of ensuring equitable access to health resources by different demographic groups. There are already considerable differences in access to health care in the world. Ensuring that differential access to the Internet along demographic lines does not exacerbate this imbalance could become an increasingly important issue, especially if the provision of health care moves online [149].

Security and legal protection are two more key issues for the diffusion of e-health [150, 151]. In fact, this approach involves three basic types of relationship [152] in which a duty is owed by one party to another:

- the relationship between the clinician and the patient;
- the relationship between clinicians; and
- the relationship between the provider of the telemedicine system and the user.

The situation may be complicated by the involvement of multiple clinicians and/or the providers of the telemedicine systems (call centers, telecommunications network, etc). As noted by Stanberry [152], if "a patient is harmed during a teleconsultation (the healthcare centre) could choose to name a number of these organizations or individuals as defendants to a legal action for negligence if it is unclear what went wrong or where responsibilities are" (p. 24).

Moreover, e-health can hide severe privacy and security risks, because patient data and hospital data stored on a secure Intranet can be manipulated by connecting it to the Web. This is even truer for e-mail consulting. Most e-mail exchanges between patient and provider involve discussions of personal health information, which must be suitably protected from breaches of confidentiality and, to a lesser extent, change [153].

However, the establishing of a firewall and the introduction of HPC (Health Professional Card) can drastically reduce the risk of unauthorized access to the hospital server. For secure e-mail, PGP (Pretty Good Privacy) can be easily used as a standard protocol [150]. Generally, planning all activities exactly and introducing advanced form of data protection are important requisites for reduction of security risks in Internet [154].

5. VREDIM: Virtual Reality for Eating DIsorders Modification

Starting from the above rationale the VEPSY UPDATED – Telemedicine and Portable Virtual Environments for Clinical Psychology - European Community funded project (IST-2000-25323) has developed the Virtual Reality for Eating DIsorders Modification - VREDIM – VR system to be used in the Experiential Cognitive Therapy. VREDIM is an enhanced version of the original Virtual Reality for Body Image Modification (VEBIM)

immersive virtual environment, previously used in different preliminary studies on non-clinical subjects [25, 27].

5.1 VREDIM: Hardware and software

VREDIM is implemented on a Thunder 1300/C virtual reality system by VRHealth, Milan, Italy (http://www.vrhealth.com). The Thunder 1300/C is a Pentium IV based immersive VR system (1300 mhz, 256 mega RAM, graphic engine: Matrox MGA 450 32Mb WRam) including a head mounted display (HMD) subsystem. The HMD used is the Glasstron from Sony Inc. The Glasstron uses LCD technology (two active matrix colour LCD's) displaying 180000 pixels each. Sony has designed its Glasstron so that no optical adjustment at all is needed, aside from tightening a two ratchet knobs to adjust for the size of the wearer's head. There's enough "eye relief" (distance from the eye to the nearest lens) that it's possible to wear glasses under the HMD. The motion tracking is provided by Intersense through its InterTrax 30 gyroscopic tracker (Azimuth: ±180 degrees; Elevation: ±80 degrees, Refresh rate: 256Hz, Latency time: 38ms ± 2).

We used a two-button joystick-type input device to provide an easy way of motion: pressing the upper button the operator moves forward, pressing the lower button the operator moves backwards. The direction of the movement is given by the rotation of operator's head.

VREDIM is composed by different 3D Healing Experiences™ (see Table 3) each one individually used by the therapist during ten 45-minute sessions with the patient (see Table 1 for the description of the different 3D Healing Experiences™ used in the sessions).

Each experience was created by using the software Virtools Dev. 2.0 (http://www.virtools.com). Based on a building-block, object-oriented paradigm, Virtools makes interactive environments and characters by importing geometry and animation from several animation packages, including Discreet 3D Studio MAX (www.discreet.com), Alias|Wavefront Maya (www.aliaswavefront.com), Softimage (www.softimage.com), and Nichimen Nendo and Mirai (www.nichimen.com), and combining them with an array of more than 200 basic behaviors. By dragging and dropping the behavior blocks together the user can combine them to create complex interactive behaviours.

The Virtools toolset consists of Virtools Creation, the production package that constructs interactive content using behavior blocks; Virtools Player, the freely distributable viewer that allows anyone to see the 3D content; Virtools Web Player, a plug-in version of the regular player for Netscape Navigator and Microsoft Internet Explorer; and the Virtools Dev for developers who create custom behaviors or combine Virtools with outside technology. Virtools Dev includes a full-blown software development kit (Virtools SDK) for the C++ developer that comes with code samples and an ActiveX player which can be used to play Virtools content in applications developed with tools such as Frontpage, Visual Basic or Visual C++.

Content created with Virtools can be targeted at the stand-alone Virtools Player, at web pages through the Virtools Web Player, at Macromedia Director, or at any product that supports ActiveX. Alternatively, the Virtools SDK allows the user to turn content into stand-alone executable files. Virtools's rendering engine supports DirectX, OpenGL, Glide and software rendering, although hardware acceleration is recommended.

5.2 VREDIM: the ten sessions

Each session is divided in three phases:

- 15 minutes of psychological individual interview;

- 15 minutes of immersion into Virtual Reality;
- 15 minutes of psychological interview.

During the first interview the therapist investigates the feelings of the subject, the iter of the therapy and will introduce the virtual reality session (table 2). In the second interview, the therapist discusses what emerged from the immersion in 3D Healing Experiences™ and analyses emotions, behaviors and cognitions of the patient.

The main goal of the first session is to introduce the patient to the procedure and to the instruments needed for exploring the virtual environments (HMD and joystick). The first session is also used to assess any body-related stimuli that could elicit abnormal eating behaviour. In particular the attention is focused on the patient's concerns about body image, eating, shape and weight. This assessment is normally part of the Temptation Exposure with Response Prevention protocol [46]. At the end of the first 3D Healing Experience™ the therapist uses the *miracle question*, a typical approach used by the solution-focused brief therapy [110, 111]. According to this approach the therapist asks the patient to imagine what life would be like without her/his complaint. Answering to this question in writing the patient constructs her/his own solution, which then guides the therapeutical process [111]. According to deShazer [111] this approach is useful for helping patients establish goals that can be used to verify the results of the therapy.

The next eight sessions are used to assess and modify:

- *the symptoms of anxiety related to food exposure.* This is done by integrating different cognitive-behavioral methods (see Table 1): Countering, Alternative Interpretation, Label Shifting, Deactivating the Illness Belief and Temptation Exposure with Response Prevention [39, 46].
- *the body experience of the subject.* To do this the virtual environment integrated the therapeutic methods (see Table 1) used by Butter & Cash [155] and Wooley & Wooley [94]. Particularly in VREDIM we used the virtual environment in the same way as guided imagery [97] is used in the cognitive and visual/motorial approach.
- *the approach to critical interpersonal settings*: using the virtual environments the patient can experience or re-experience critical interpersonal situations and *reframe* them, using different cognitive-behavioral methods (see Table 1): Countering, Alternative Interpretation and Label Shifting. Moreover, the therapist presents the patients applicable ways of honestly *communicating their feelings* during the interaction (assertiveness training).

The conclusive session is used for a final analysis of the inpatient/outpatient phase with particular attention to the reached goals, prevention of relapses and maintenance of the therapeutic compliance in the forthcoming outpatient phase.

In all the sessions, the therapists followed the Socratic style: they used a series of questions, related to the contents of the virtual environment, to help clients synthesize information and reach conclusions on their own.

5.3 VREDIM: The 3D Healing Experiences™

Each session of Virtual Reality (15 minutes) is divided into three phases reached through successive virtual doors (see Table 2):

The *psychologist's office* is the first 3D Healing Experience™. It represents the start and the end of each session, and it has the important function to outline boundaries of the session in virtual reality. It is a neutral and reassuring place which allows continuity in the phases of the individual session: face to face, virtual reality and face to face.

Table 2. Phases included in each VR session

PHASE 1	Psychologist Office
PHASE 2	Specific 3D Healing Experience
PHASE 3	Psychologist Office

In the psychologist's office there are the following objects: a writing-desk with two comfortable chairs, a bookshelf and complements of furnishings that make the environment more comfortable and hospitable (pictures, carpets, lamps, green plants, etc.)
The full list of the environments used is reported in Table 3. Below is reported a more detailed description of all the 3D Healing Experiences™ used in the ten sessions.

5.3.1 Virtual Balance (First session)

The room of the virtual balance is a not very wide environment with windows. The patient can come up to weight herself on the balance in the middle of the room. When the patient comes up on the virtual balance her weight, which has previously been typed in, appears on the display.

This experience is used by the therapist to explore any symptoms of anxiety related to the experience of weighting in the patients and their concerns about eating, shape and weight. The data collected are used to plan the next sessions.

Key questions used for the assessment phase

Reaction to the virtual balance

- What can you see there?
- What are your feelings/sensations?
- Do you have a balance at home?
- Where do you keep it?

Concern about weight

- Do you often weight yourself? How often in a week?
- Now come up to the scales... Touch it *(The therapist "takes" the patient, and the patient's weight, which has earlier been typed in, appears)*. Now tell me how you feel when you see your weight on the display...

Wish to modify one's weight

- Have you tried to do something about your weight in the last few months? How?
- How do you feel when you can't manage to change your weight despite the effort? What do you do to feel better?
- What happens instead when you can manage to change your weight?
- Now imagine that you can change the figures on the display... what figures would you like to appear?
- In your opinion, is it a reasonable weight considering your age, height and actual weight?
- How would you feel if this was your weight?

Influence of one's own weight on the opinions of others

- When you weight yourself, are you alone? Always? *(If so)* Why? Would you feel uneasy if others (relatives, friends) saw your weight?
- If you couldn't be alone, who would you like to be with when weight yourself? What does this other person think about your weight?
- In your opinion, what do you think the significant others think about your weight? Do you think they give importance to your weight when they judge you?

- *(The therapist expresses his question specifying four groups of people: relatives, friends, acquaintances and strangers)*
- Would you be able to tell me what the significant others think about you beside your weight? *(Also here the therapist expresses his question specifying four groups of people: relatives, friends, acquaintances and strangers).*

Influence of weight on one's opinion of oneself

- Do you think your life would be different if you had a different weight?
- When you see your weight on the balance and notice a difference *(The therapist supposes both an increase and a decrease of weight)*, what do you think of yourself?
- If in this very moment you had to list the things that are most important to you (work or study, family, friends, etc.) what the rating of weight is?

Influence of other people's weight on one's opinion.

- What do you tell to a friend who has the same weight as your?
- When you see somebody who is overweight/underweight *(The therapist chooses the choices that corresponds to the patient's characteristics)*, what do you think about that person?
- Do you think that an overweight/underweight person is happy? *(If So)* Always? *(Through this question the therapist gets the patient to understand the mistake of generalization)*

5.3.2 Sitting room (First session)

This 3D Healing Experience™ is used in the first session to allow the patients to familiarize with the virtual reality tools (HMD, joystick) and to learn to move into the virtual environments.

Into the sitting room there are wide windows, a sofa, two comfortable armchairs, a bookshelf, a cocktail cabinet, a table with four chairs and food on it. Complements of furnishings were inserted to make the environment more comfortable (pictures, carpets, lamps, green plants, vases, etc.). Moreover in the room there are some specific objects (TV, HI-FI, phone, newspapers, etc.) that are used to suggest to the patients substitutive behaviors to dysfunctional food intake during the "critical" moments.

The patients can perform some different actions and interact with several objects: to open the cocktail cabinet, to listen music, to watch the television, etc.

This environment is used to identify any symptoms of anxiety related to interpersonal relationships in the patients. These data, too, are collected and used to plan the next sessions.

Table 3. 3D Healing Experiences™ used in VREDIM

1st 3D Healing Experience	Virtual balance
2nd 3D Healing Experience	Sitting room
3rd 3D Healing Experience	Kitchen
4th 3D Healing Experience	Bedroom
5th 3D Healing Experience	Bathroom
6th 3D Healing Experience	BIVRS
7th 3D Healing Experience	9 doors room
8th 3D Healing Experience	Shopping centre
9th 3D Healing Experience	Supermarket
10th 3D Healing Experience	Gymnasium
11th 3D Healing Experience	Pub
12th 3D Healing Experience	Clothes shop
13th 3D Healing Experience	Restaurant
14th 3D Healing Experience	Swimming pool + beach

Key questions used for the assessment phase

Interpersonal relationships

- Do you like staying at home? *(If the patient expresses a preference)* What do you think the reason is?
- *(If the patient dislikes it)* Is there anything that bothers you at home? What are your relations with your relatives *(The therapist expresses his question specifying the different relatives: mother, father, brother/s, sister/s).*
- *(If the patient likes it)* Is there something that bothers you outside? Other people make you feel uneasy? Why? Is it because of your body?
- Do you think other people look at you because of your body? *(The therapist expresses his question specifying four groups of people: relatives, friends, acquaintances and strangers)*
- What do they think of you?
- Do you think they are right?
- If they noticed your weight has changed *(The therapist supposes both an increase and a decrease of weight)*, what would they think of you? *(The therapist expresses his question specifying four groups of people: relatives, friends, acquaintances and strangers)*

5.3.3 Kitchen (Second and Tenth sessions)

The kitchen is the first environment of the second virtual reality session. The virtual room is a quite wide environment with windows, an equipped kitchen (refrigerator, oven, gas-ring, sink, mixer, toaster, etc.), a wide shelf of job, spacious cupboards, a table with four chairs.

Into the kitchen the subject can interact with the presented objects: she can open the cupboards, the refrigerator, the freezer and the oven. Moreover, she can choose and "eat" any of the available food.

As in the previous session, the therapist analyzes the reactions elicited by food.

Moreover, any dysfunctional belief and/or feeling are discussed with the patient according to the Label Shifting and Objective Counters methods. The kitchen setting is also used to explore the relationships with other family members (father, mother, brother/s and sister/s).

5.3.4 Bathroom (Second session)

In the virtual flat there is also a bathroom that is useful to investigate feelings, sensations and thoughts, of the patients with inappropriate compensatory methods as self-induced vomiting and misuse of laxatives.

In add to the sanitary fittings (shower, bath, wash-basin, WC) in the bathroom there are some towels, a bath-robe, a big mirror, a bath closet, a scales, etc.

The patients can do the following actions: to open the shutters, to enter in the shower, to open the taps of the bath, of the shower and of the wash-basin, etc.

In presence of compensatory behaviors the Temptation Exposure with Response Prevention method is used. Any dysfunctional belief and/or feeling are discussed with the patient according to the Label Shifting and Objective Counters methods.

5.3.5 Bedroom (Second session)

The bedroom is used instead with patients having binge episodes in this room or that have difficulties in eating control (night eaters) during the night.

The room is quite large, and the wide windows make it very bright. In the bedroom there is a king bed, two bedside tables with abajour, a big wardrobe, a clothes-hanger, a bookshelf, some shelves, a writing-desk with a computer and a chair. The patients can perform some different actions: to open the wardrobe, to interact with the present food, to eat virtually the food, etc. As in the previous session, the Temptation Exposure with Response Prevention is used in presence of compensatory behaviors. Moreover, the different dysfunctional beliefs and/or feelings are discussed with the patient according to the Label Shifting and Objective Counters methods.

5.3.6 BIVRS (Third and Tenth sessions)

This 3D Healing Experience™ - the Body Image Virtual Reality Scale - BIVRS - is a three part virtual world in which the user has to choose between 9 figures of different size which vary from underweight to overweight [114, 156].

Subjects are asked to choose the figures that they think to reflect their current and their ideal body sizes. The discrepancy between these two measures is an indication of their level of dissatisfaction. In the first two zones (one for real body and one for ideal body) the subject chooses between nine 2D images that are shown simultaneously. Opening the central door the patient enters in a third zone where there are two panels showing the ideal body and the real body chosen by the subject in the two preceding zones. The two silhouettes are now presented in 3D and between them is presented the real picture of the patient previously digitised using an EPSON Photo PC camera. The 3D images can be modified using two arrow buttons located around the images.

We decided to use both 2D and 3D images to improve the effectiveness of the scale.

Even if existing body image scales use mainly 2D images, using 3D it is easier for the subject to perceive the differences between the silhouettes, especially for specific body areas (breasts, stomach, hips and thighs). Also, here the patients can perform some different actions and interact with several objects: to open the doors, to choose the panels, to turn on the silhouette, etc.

The vision of her own body usually elicits in the user strong feelings that can be matched using the Counterattacking and the Countering cognitive methods. The mirror is also used, as indicated by Wooley and Wooley [94], to develop an awareness of the body image distortion. Finally, the therapist instructs the patient to imagine herself as different on several dimensions including size, race, and being larger or smaller particularly areas.

The subject is also asked to imagine herself as younger, older, what they look and feel like before and after eating and social successes/failures.

5.3.7 Nine doors room 9 (Tenth session)

In this room the patient is in front of 9 doors of different sizes varying gradually from the narrowest to the largest. The subject can proceed to the next room only by choosing the door corresponding to her body dimension (earlier inserted in the computer by the therapist).

In this room the patients can open only the door corresponding to the size of your hips. When the patient makes a mistake, she is not being able to open the chosen door.

The experience is used as stimuli to support a cognitive approach: the elicited feelings are analysed by the therapist according to the Label Shifting and Objective Counters methods. The feelings and their associated beliefs are identified, broken down into their logical components, replaced with two or more descriptive words, and then critically analysed.

5.3.8 Shopping Mall (Fourth, Fifth, Sixth, Seventh and Eight sessions)

This is the more complex environment of our virtual reality system. Into the shopping centre there are several shops and commercial activities - a supermarket, a clothes shop, a gymnasium, a pub, a restaurant - that the patient will explore during different sessions.
The shopping centre is very large and bright. The patient navigating in this environment can observe many people, the shopwindows and the different signs.

5.3.8.1 Supermarket (Fourth session)

The supermarket is divided in different departments: fruit and vegetables, cakes and biscuits, cheese and dairy products, pork products, meat and fish, sweets, drinks and alcoholic drinks, deep-frozen food, etc.

Into the supermarket there are many people. Near the exit of the supermarket there are two cash-desks, but only one of these is free.

Also in this session the patients can perform some different actions and interact with several objects: to put the food acquired in the shopping bag, to put back the wrong purchases in the shelves, to eat immediately something, to do a list of food, to pay at the cash-desk, etc.

If the patient activates maladaptive behaviors the Temptation Exposure with Response Prevention is used. Moreover, the different dysfunctional beliefs and/or feelings are discussed with the patient according to the Label Shifting and Objective Counters methods.

5.3.8.2 Gymnasium (Fifth session)

This virtual environment is divided in four parts:

- Entrance,
- Female dressing room,
- Cyclette and tapie roulant room,
- Fitness room.

Entering in the gymnasium the patient crosses the entrance that has a writing-desk with a computer, chairs, a comfortable sofa, a table with newspapers, scales, a carpet, some posters, etc.

In the female dressing room there are some cabinets, clothes-hangers, platform seats, a big mirror, sports bag, shoes and wears.

In the first room of the gymnasium there are some cyclette, a tapie roulant, a side for exercises, mirrors, TV, HI-FI, etc. In the second room there are different fitness machines. In each room of the gymnasium there are many people with sports wear (females and males).

Also in this session the patients can perform some different actions and interact with several objects.

This session is used to reframe the effect of negative appearance related comments from others. Specifically, using the Countering, Alternative Interpretation and Label Shifting methods the patient is instructed to recognize the irrational beliefs (i.e. "I must look good to be liked") that usually underlie the interpretation of the comments. The environment is also used to explore the interpersonal relationships outside the family.

5.3.8.3 Pub (Sixth session)

The pub is a very large room arranged in four different areas:

- Counter bar;
- Tables;
- Live music zone;
- Game zone.

The counter bar is well furnished: alcoholic drinks and soft drinks, beer, sweet dispenser, snack dispenser (cheeps, salts, pop corn, etc.), sandwiches, pizza, toast, etc.; near to the counter there is the freezer with ice-creams listed on a sign-board

In the zone of the tables the patient can find a big screen, some posters, green plants. On the engaged tables there are some drinks (beer, coke, fruit juice, etc.) and some food (salts, sandwiches, toast, ice-cream, slices of cake etc.).

The patients can sit down because there is a free table. They can choose food and/or drinks, listen music, watch the video on the big screen, eat and drink virtually, see the people into the pub, etc.

If the patient activates maladaptive behaviors or binge eating the Temptation Exposure with Response Prevention is used. Moreover, the different dysfunctional beliefs and/or feelings are discussed with the patient according to the Label Shifting and Objective Counters methods. Finally, the environment is used to further explore the interpersonal relationships outside the family.

5.3.8.4 Clothes shop (Seventh session)

After to have seen the shop-windows of the clothes shop the patient enters in the little environment subdivided in two parts:

- The inner shop;
- Two dressing rooms.

Inside the shop the wears are arranged on different shelves and clothes-hangers. Moreover in the shop there are some mirrors, manikins, a counter and two dressing rooms.

In the two dressing rooms develops the second part of the seven sessions. In each dressing room can be found a mirror, a chair, a clothes-hanger and with T-shirts (in the first room) and trousers (in the second) of different sizes.

Also in this room the patients can perform some different actions and interact with several objects: to open the doors of the dressing room, to wear T-shirts and trousers, to look herself in the mirror, etc.

Also, this session is used to reframe the effect of negative appearance related comments from others. Specifically, using the Countering, Alternative Interpretation and Label Shifting methods the patient is instructed to recognize the irrational beliefs (i.e. "I must look good to be liked") that usually underlie the interpretation of the comments. The mirror is also used, as shown by Wooley and Wooley [94], to instruct the user to imagine herself as different on several dimensions including size, race, and being larger or smaller in specific areas. The subject is also asked to imagine herself as younger, older, what they look and feel like before and after eating and social successes/failures.

5.3.8.5 Restaurant (Eighth session)

The restaurant is a little and hospitable environment. The little hall allows to enter the room with the tables where the patient can sit-down. In the room there are differently engaged tables, comfortable chairs, trolley with cakes and a cocktail cabinet. The patients can perform some different actions and interact with several objects into the restaurant: to sit down at the table, to open and read the menu and to eat and drink virtually.

If the patient activates maladaptive behaviors or binge eating the Temptation Exposure with Response Prevention is used. Moreover, the different dysfunctional beliefs and/or feelings are discussed with the patient according to the Label Shifting and Objective Counters methods.

5.3.9 Swimming pool and beach (Ninth session)

The swimming pool and the beach are two different places but inserted in the same virtual environment.

When the patients enter this environment they find themselves in front of a swimming pool surrounded by deck-chairs, towels on the floor, and people sunbathing on the lawn and on the edge of the swimming pool. Some people have a swim.

A path connects the swimming pool with the beach. On the beach there are some people that sunbathe, walk, swim, chat and there are children that play, etc. On the beach there are deck-chairs, beach-umbrellas, dressing room, paddleboat; while in the sea there are some windsurf that move. In this session the patients cannot interact with the objects.

The reframing of the impact of negative appearance related comments from others is the main goal of this session. As before, using the Countering, Alternative Interpretation and Label Shifting methods the patient is instructed to recognize the irrational beliefs that underlie the interpretation of the comments.

6 Clinical Trials

6.1 Subjects

Subjects are 120 women, aged 18-50 years (Mean age: 33,07 ±8,08 yrs; Mean weight: 105,44 ±17,73 Kg.; Mean height: 1,62 ±0,06 cm; Mean B.M.I.: 39,80 ±6,10) After diagnostic assessment, subjects were categorized as Obese (68 subjects) and Eating Disorders (36 Binge Eaters; 12 Bulimics and 3 Eaters Disorder not otherwise specified).

Subjects were then randomly assigned to the experimental group and to the three control groups as following:

- **Experimental group** (Experiential-Cognitive Therapy)

30 subjects; Mean age: 33,43 ±8,29 yrs; Mean weight: 104,25 ±19,98 Kg; Mean height: 1,62 ±0,07 cm; Mean B.M.I.: 39,56 ±6,20;

- **Control Group I** (Cognitive-Behavioral Therapy)

30 subjects; Mean age: 32,2 ±7,95 yrs; Mean weight: 107,63 ±11,62 Kg; Mean height: 1,62 ±0,05 cm; Mean B.M.I.: 41,14 ±5,70;

- **Control Group II** (Nutritional Group)

30 subjects; Mean age: 33,5 ±8,17 yrs; Mean weight: 105,59 ±19,76 Kg; Mean height: 1,62 ±0,07 cm; Mean B.M.I.: 39,95 ±6,40;

- **Control Group III** (Waiting List)

30 subjects; Mean age: 33,16 ±8,25 yrs; Mean weight: 104,3 ±18,91 Kg; Mean height: 1,64 ±0,06 cm; Mean B.M.I.: 38,56 ±6,09.

Individuals were excluded if they were acutely suicidal, medically ill or pregnant, had abused alcohol or drugs within the last year or had evidence of cardiac conduction disease.

The study received ethical approval by Ethical Committee of the Istituto Auxologico Italiano. Before starting the trial, the nature of the treatment was explained to the patients and her written informed consent was obtained.

6.2 Assessment

Subjects were assessed by one of three independent assessment clinicians who were not involved in the direct clinical care of any subject. They were two MA-level chartered psychologists and a PhD-level chartered psychotherapist. All subjects were assessed at pre-treatment and upon completion of the clinical trial.

The following psychometric tests were obtained at entry to the study:

- Eysenck Personality Inventory EPI (H.J. Eysenck & S. Eysenck, 1964) – Italian Version (O.S., 1976)
- Italian version of the Eating Disorders Inventory 2 - EDI 2 [I].

Moreover, the following psychometric tests were administered at each assessment point:

- Italian version [IV] of the State-Trait Anxiety Inventory -STAI [V];
- Beck Depression Inventory (A.T. Beck, C.H. Ward, M. Mendelson, J. Mock & J. Erbaugh, 1961);
- Rosenberg Self-Esteem Questionnaire (M. Rosenberg, 1965);
- Rathus Assertion Schedule (S.A. Rathus, 1973) – Italian Version (M. Campanelli & A. Tamburello; 1979)
- Italian version [II] of the Dieter's Inventoy of Eating Temptations [III]. The inventory has 30 items, each presenting a situational description along with a competent response. The subject rates the percentage of time he or she would behave as described in similar situations. A total score and six subscales are computed. The subscales are Resisting Temptation, Positive Social, Food Choice, Exercise, Overeating and Negative Emotions. The inventory was originally designed for use with obese individuals who are trying to lose weight in behavioral weight loss programs, but, according to the authors, it may be useful for identifying situations most likely to trigger loss of control by bulimic patients.
- Italian version (Riva, Bacchetta, & Baruffi, 1999b) of the Weight Efficacy Life-Style Questionnaire - WELSQ (Clark, Abrams, Niaura, Eaton, & Rossi, 1991a). The WELSQ is composed by 20 items that measure the confidence of the subjects about being able to successfully resist the desire to eat using a 10-point scale ranging from 0 (not confident) to 9 (very confident). The questionnaire was used to predict both acute change and long-term maintenance of weight loss across a range of ages in man and women (Clark et al., 1991a).
- Italian version [VI] of the University of Rhode Island Change Assessment Scale - URICA [VII] . The URICA consists of 32 items designed to measure four stages of change in psychotherapy: *pre-contemplation*, *contemplation*, *action* and *maintenance*. Each item is scored using a 5-point Likert-type format: higher scores indicate greater agreement with statements. The URICA was originally developed for use with clients

in psychotherapy reporting on their problems. However the instrument is also used for measuring readiness to change across a wide variety of problem behaviors, expecially the addictions including smoking cessation, alcohol use, and cocaine use.

- Italian version [VIII] of the Body Satisfaction Scale - BSS [IX]. The scale consists of a list of 16 body parts, half involving the head (above the neck) and the other half involving the body (below the head). The subjects rate their satisfaction with each of these body-parts on a seven-point scale: the higher the rating, the more dissatisfied the individual. A total score and three subscale scores are computed for head, torso and limbs items. The scale was designed for work in health-related fields. In particular the scale was used by the authors to assess body dissatisfaction in eating disorders, to monitor changes in body satisfaction in subjects undergoing surgical treatment for breast cancer and to determine the psychological effects of either maxillary or mandibular joint surgery.
- Italian version [X] of the Body Image Avoidance Questionnaire - BIAQ [XI]. The BIAQ is 19-item self-report questionnaire on avoidance of situations that provoke concern about physical appearance, such avoidance of tight-fitting clothes, social outings, and physical intimacy. In particular the questionnaire measures the avoidance behaviors and grooming habits associated with negative body image (Rosen et al., 1991). The questionnaire uses a 6-point scale to rate frequency of behavior: never, rarely, sometimes, often, usually, and always. A total score and four subscales are computed for: clothing, social activities, eating restraint and grooming/weighing.
- The Contour Drawing Rating Scale - CDRS [XIII], a set of 9 male and female figures with precisely graduated increments between adjacent sizes. In this test subjects rate the figures based on the following instructional protocol, (a) current size and (b) ideal size. The difference between the ratings is called the *self-ideal discrepancy score* and is considered to represent the individual's dissatisfaction.

6.3 Treatment

The design of the investigation is outlined in the following schema:

Experimental Group

A. Psychological Iter:

- Psychodiagnostic assessment (Administration of psychometric tests and Individual Psychological Assessment);
- 5 sessions of psychological groups;
- 10 individual sessions of Virtual Reality with psychological interview;

B. Nutritional Iter:

- 1 interview for nutritional assessment;
- personalized balanced dieting;
- 4/6 sessions of nutritional groups.

C. Physical Iter:

- Physical activity (physical activities, cyclette, walking, etc.)
- Physiotherapy if necessary.

Control Group I (Cognitive-Behavioral Therapy)

A. Psychological Iter:

- Psychodiagnostic assessment (Administration of psychometric tests and Individual Psychological Assessment);

- 5 sessions of psychological groups;
- 10 Individual Psychological sessions.

B. Nutritional Iter:

- 1 interview for nutritional assessment;
- personalized balanced dieting;
- 4/6 sessions of nutritional groups.

C. Physical Iter:

- Physical activity (physical activities, cyclette, walking, etc.)
- Physiotherapy if necessary.

Control Group II (Nutritional Group)

A. Psychological Iter:

- Psychodiagnostic assessment (Administration of psychometric tests and Individual Psychological Assessment);
- Psychological support (once a week);

B. Nutritional Iter:

- 1 interview for nutritional assessment;
- personalized balanced dieting;
- 4/6 sessions of nutritional groups.

C. Physical Iter:

- Physical activity (physical activities, cyclette, walking, etc.)
- Physiotherapy if necessary.

Control Group III (Waiting List)

- No inpatient phase.
- Psychodiagnostic assessment (Administration of psychometric tests and Individual assessment);
- Administration of psychometric tests (after one month).

6.4 Statistical analysis

A power calculation was made to verify the opportunity to obtain statistically significant differences between the pre- and post-treatment scores. The Wilcoxon non-parametric test was then carried out to test the effect of the treatments.

Data obtained from patients with patients with diagnosis of Bulimia Nervosa and of Eating Disorders (Not Otherwise Specified) were excluded from statistic analysis because the size of the respective sample was too small.

6.5 Outcome

In this section the outcome of statistical analysis is provided. In order to present results more clearly, tables 4-6 show respectively psychological, physiological and behavioral changes between the start and the end of the treatment in the BED Group; tables 7-9 show psychological, physiological and behavioral changes between the start and the end of the treatment in the OBESE Group. In each table, significant contrasts are marked in bold font.

Table 4. Psychological changes between the start and the end of the treatment in the BED Group (Z: Wilcoxon non parametric test; significant values are marked in bold font)

	Experiential Cognitive Group		***Cognitive Behavioral Group***		***Nutritional Group***		***Waiting List***	
Psychological scales	*Z*	*p*	*Z*	*p*	*Z*	*p*	*Z*	*p*
STAI Total Score	-2.371	**0.018**	-1.481	0.139	-2.490	**0.013**	-2.016	**0.044**
BDI Total Score	-2.670	**0.008**	-1.963	**0.050**	-1.604	0.109	-1.122	0.262
Rosenberg Self Esteem Total Score	-2.375	**0.018**	-2.527	**0.012**	-2.546	**0.011**	-0.175	0.861
Rathus Assertion Schedule – F. 1-2 Rathus Assertion Schedule – F. 1-1	-1.366	0.172	-1.785	0.074	-2.136	**0.033**	-0.595	0.552
Rathus Assertion Schedule – F. 2-2 Rathus Assertion Schedule – F. 2-1	-2.428	**0.015**	-1.866	0.062	-1.786	0.074	-1.121	0.262
Rathus Assertion Schedule – F. 3.2 Rathus Assertion Schedule – F. 3-1	-0.423	0.672	-1.876	0.061	-1.734	0.083	-1.382	0.167
Rathus Assertion Schedule – F. 4-2 Rathus Assertion Schedule – F. 4-1	-1.691	0.091	-1.057	0.291	-1.965	0.049	-1.275	0.202
Rathus Assertion Schedule – F. 5-2 Rathus Assertion Schedule – F. 5-1	-2.388	**0.017**	-1.310	0.190	-0.427	0.669	-1.890	0.059
Rathus Assertion Schedule – F. 6-2 Rathus Assertion Schedule – F. 6-1	-0.850	0.395	-1.186	0.236	-1.518	0.129	0.0	1.0
Diet Overeating 2 – Diet Overeating 1	-2.429	**0.015**	-1.960	**0.050**	-2.240	**0.025**	-0.535	0.592
Diet Negative Emotions 2 – Diet Negative Emotions 1	-1.199	0.230	-1.619	0.105	-0.949	0.342	-0.339	0.735
Diet Positive Social 2 – Diet Positive Social 1	-1.718	0.086	-1.424	0.154	-2.192	**0.028**	-1.248	0.212
Diet Food Choice 2 – Diet Food Choice 1	-0.535	0.592	-1.053	0.292	-0.631	0.528	-0.341	0.733
Diet Resisting Temptations 2- Diet Resisting Temptations 1	-1.599	0.110	-1.843	0.065	-2.552	**0.011**	-1.689	0.091
Diet Exercise 2 – Diet Exercise 1	0.000	1.000	-0.508	0.611	-0.237	0.812	-0.239	0.811
Diet Total Score 2- Diet Total Score 1	-0.711	0.477	-1.011	0.312	-2.243	**0.025**	-0.889	0.374
Body Image Avoidance Quest. – Clothing 2- Body Image Avoidance Questionnaire – Clothing 1	-2.536	**0.011**	-1.620	0.105	-2.692	**0.007**	-0.513	0.608
Body Image Avoidance Quest. – Grooming/weighing 2- Body Image Avoidance Questionnaire – Grooming/weighing 1	-1.382	0.167	-1.706	0.088	-1.279	0.201	-0.171	0.865
Body Image Avoidance Quest. –Eating Restraint 2- Body Image Avoidance Questionnaire – Eating Restraint 1	-0.779	0.436	-1.735	0.083	-1.411	0.158	-2.111	**0.035**

Body Image Avoidance Quest. – Social Activities 2- Body Image Avoidance Questionnaire – Social Activities 1	-2.521	**0.012**	-1.612	0.107	-1.620	0.105	-1.380	0.168
Body Image Avoidance Quest. – Total 2- Body Image Avoidance Questionnaire – Total 1	-2.547	**0.011**	-1.334	0.182	-1.474	0.141	-1.965	**0.049**
Weight Efficacy Life Style – Total 2 - Weight Efficacy Life Style – Total 1	-2.666	**0.008**	-2.666	**0.008**	-2.310	**0.021**	-0.652	0.515
Body Satisfaction Scale – Head 2 – Body Satisfaction Scale – Head 1	-1.863	0.063	-0.211	0.833	-2.379	**0.017**	-0.983	0.326
Body Satisfaction Scale – Torso 2 – Body Satisfaction Scale – Torso 1	-2.043	**0.041**	-1.612	0.107	-0.172	0.863	-1.913	0.056
Body Satisfaction Scale – Limbs 2 – Body Satisfaction Scale – Limbs 1 –	-1.866	0.062	-1.895	0.058	-1.474	0.141	-0.935	0.350
Body Satisfaction Scale – Total 2 – Body Satisfaction Scale – Total 1 –	-2.371	**0.018**	-1.187	0.235	-2.383	**0.017**	-1.609	0.108
CDRS – real body 2 – CDRS – real body 1	-2.070	**0.038**	-2.000	**0.046**	-1.890	0.059	0.000	1.000
CDRS – ideal body 2 – CDRS – ideal body 1	-1.414	0.157	-1.414	0.157	-0.378	0.705	-0.816	0.414
CDRS – body dissatisfaction 2 – CDRS – body dissatisfaction 1	-2.388	**0.017**	-2.201	**0.028**	-1.363	0.173	-0.535	0.593
URICA - pre-contemplation 2 URICA - pre-contemplation 1	-0.171	0.864	-0.178	0.859	-0.849	0.396	-0.679	-0.497
URICA - contemplation 2 – URICA -contemplation 1	-1.015	0.310	-0.423	0.672	-1.078	0.281	-0.085	0.932
URICA - action 2 – URICA - action 1 -	-1.136	0.256	-2.388	**0.017**	-1.205	0.228	-0.071	0.943
URICA – maintenance 2 – URICA maintenance 1	-0.837	0.402	-0.656	0.512	-2.138	**0.033**	-0.705	0.481
URICA Total 2 – URICA Total 1	-0.949	0.342	-0.775	0.438	-2.670	**0.008**	-0.771	0.441

Table 5. Physiological changes between the start and the end of the treatment in the BED Group (Z: Wilcoxon non parametric test; significant values are marked in bold font)

	Experiential Cognitive Group		*Cognitive Behavioral Group*		*Nutritional Group*		*Waiting List*	
Physiological data	*Before*	*After*	*Before*	*After*	*Before*	After	*Before*	*After*
Weight	102.7+/-17.2	97.2+/-15.6	109.3+/-10.5	102.1+/-9.14	103.8+/-21.3	97.0+/-19.3	105.5+/-17.2	107.3+/-17.3
	Z	*p*	*Z*	*p*	*Z*	*p*	*Z*	*p*
	-2.666	**0.008**	-2.666	**0.008**	-2.666	**0.008**	-2.375	**0.018**
Body Mass Index	41.2+/-4.5	39.0+/-4.2	42.3+/-2.9	39.6+/-2.7	41.6+/-7.1	38.9+/-6.7	39.1+/-4.5	39.7+/-4.5
	Z	*p*	*Z*	*p*	*Z*	*p*	*Z*	*p*
	-2.666	**0.008**	-2.666	**0.008**	-2.666	**0.008**	-2.366	**0.018**
Hips width	42.3+/-3.1	40.7+/-2.6	44.5+/-5.7	42.55+/-5.84	41.3+/-4.0	39.4+/-4.0	no data	no data
	Z	*p*	*Z*	*p*	*Z*	*p*	*Z*	*p*
	-2.375	**0.018**	-2.536	**0.011**	-2.694	**0.007**	no data	no data

Table 6. Behavioral changes between the start and the end of the treatment in the BED Group (Z: Wilcoxon non parametric test; significant values are marked in bold font)

	Experiential Cognitive Group		*Cognitive Behavioral Group*		*Nutritional Group*		*Waiting List*	
Physiological data	*Before*	**After**	*Before*	*After*	*Before*	*After*	*Before*	*After*
Binge	13.3+/-6.6	0.0	12.8+/-6.9	0.0	23.3+/-10.5	0.0	20.0+/-17.4	17.3+/-17.0
	Z	*p*	*Z*	*p*	*Z*	*p*	*Z*	*p*
	-2.699	**0.007**	-2.684	**0.007**	-2.670	**0.008**	-1.289	0.197
Vomiting	0.0	0.0	1.5+/-4	0.0	0.0	0.0	0.0	0.0
	Z	*p*	*Z*	*p*	*Z*	*p*	*Z*	*p*
	0	1	-1.342	0.180	0	1	0	1
Laxative	0.0	0.0	2.2+/-6.7	0.0	0.0	0.0	0.0	0.0
	Z	*p*	*Z*	*p*	*Z*	*p*	*Z*	*p*
	0	1	-1.000	0.317	0	1	0	1

Table 7. Psychological changes between the start and the end of the treatment in the OBESE Group (Z: Wilcoxon non parametric test; significant values are marked in bold font)

	Experiential Cognitive Group		***Cognitive Behavioral Group***		***Nutritional Group***		***Waiting List***	
Psychological scales	*Z*	*p*	*Z*	*p*	*Z*	*p*	*Z*	*p*
STAI Total Score	-2.071	**0.038**	-2.500	**0.012**	-2.325	**0.020**	-0.207	0.836
BDI Total Score	-3.187	**0.001**	-2.589	**0.010**	-1.813	0.70	-0.491	0.626
Rosenberg Self Esteem Total Score	-2.968	**0.003**	-2.439	**0.015**	-1.903	0.057	-0.365	0.715
Rathus Assertion Schedule – F. 1-2; Rathus Assertion Schedule – F. 1-1	-2.582	**0.004**	-2.464	**0.014**	-1.494	0.135	-0.910	0.363
Rathus Assertion Schedule – F. 2-2; Rathus Assertion Schedule – F. 2-1	-2.025	**0.043**	-1.850	0.064	-1.350	0.177	-0.673	0.524
Rathus Assertion Schedule – F. 3.2; Rathus Assertion Schedule – F. 3-1	-2.369	**0.018**	-2.145	**0.032**	-1.208	0.227	-0.857	0.391
Rathus Assertion Schedule – F. 4-2: Rathus Assertion Schedule – F. 4-1	-3.292	**0.001**	-0.600	0.549	-1.928	0.054	-0.143	0.887
Rathus Assertion Schedule – F. 5-2: Rathus Assertion Schedule – F. 5-1	-1.314	0.189	-0.984	0.325	-0.964	0.335	-0.660	0.509
Rathus Assertion Schedule – F. 6-2; Rathus Assertion Schedule – F. 6-1	-0.432	0.666	-2.140	**0.032**	-0.406	0.685	-0.513	0.608
Diet Overeating 2 – Diet Overeating 1	-3.154	**0.002**	-2.924	**0.003**	-2.316	**0.021**	-0.398	0.690
Diet Negative Emotions 2- Diet Negative Emotions 1	-1.588	0.112	0.000	1.000	-0.492	0.623	-0.370	0.711
Diet Positive Social 2 – Diet Positive Social 1	-2.767	**0.006**	-2.110	**0.035**	-2.392	**0.017**	-0.966	0.334
Diet Food Choice 2 – Diet Food Choice 1	-1.552	0.121	-1.062	0.288	-0.410	0.682	-0.596	0.551
Diet Resisting Temptations 2 – Diet Resisting Temptations 1	-2.393	**0.017**	-3.184	**0.001**	-1.132	0.258	-0.422	0.673
Diet Exercise 2 – Diet Exercise 1	-0.208	0.836	-1.529	0.126	-1.855	0.064	-1.056	0.291
Diet Total Score 2 - Diet Total Score 1	-2.638	**0.008**	-1.397	0.162	-2.059	**0.039**	-0.284	0.776
Body Image Avoidance Quest. – Clothing 2- Body Image Avoidance Questionnaire - Clothing 1	-3.317	**0.001**	-2.350	**0.019**	-1.325	0.185	-0.811	0.417
Body Image Avoidance Quest. – Grooming/weighing 2- Body Image Avoidance Questionnaire – Grooming/weighing 1	-1.554	0.120	-0.791	0.429	-2.166	**0.030**	-0.603	0.546
Body Image Avoidance Quest. –Eating Restraint 2- Body Image Avoidance Questionnaire – Eating Restraint 1	-2.180	**0.029**	-0.434	0.665	-0.095	0.924	-1.355	0.176

Body Image Avoidance Quest. – Social Activities 2- Body Image Avoidance Questionnaire – Social Activities 1	-3.265	**0.001**	-3.162	**0.002**	-2.994	**0.003**	-2.000	**0.46**
Body Image Avoidance Quest. – Total 2- Body Image Avoidance Questionnaire – Total 1	-3.199	**0.001**	-2.586	**0.010**	-2.140	**0.032**	-1.127	0.260
Weight Efficacy Life Style – Total 2 - Weight Efficacy Life Style – Total 1	-3.575	**0.000**	-3.575	**0.000**	-2.557	**0.011**	-0.597	0.551
Body Satisfaction Scale – Head 2 – Body Satisfaction Scale – Head 1	-0.315	0.753	-2.359	**0.018**	-1.698	0.089	-0.409	0.682
Body Satisfaction Scale – Torso 2 – Body Satisfaction Scale – Torso 1	-3.201	**0.001**	-2.134	**0.033**	-3.346	**0.001**	-0.319	0.750
Body Satisfaction Scale – Limbs 2 – Body Satisfaction Scale – Limbs 1 –	-2.366	**0.018**	-1.998	**0.046**	-2.803	**0.005**	-0.60	0.953
Body Satisfaction Scale – Total 2 – Body Satisfaction Scale – Total 1 –	-2.691	**0.007**	-2.640	**0.008**	-3.056	**0.002**	-0.171	0.864
CDRS – real body 2 – CDRS – real body 1	-1.931	**0.053**	-2.511	**0.012**	-2.653	**0.008**	-1.732	0.083
CDRS – ideal body 2 – CDRS – ideal body 1	-0.513	0.608	-1.732	0.083	-2.111	**0.035**	-1.414	0.157
CDRS – body dissatisfaction 2 – CDRS – body dissatisfaction 1	-0.966	0.334	-2.587	**0.010**	-2.798	**0.005**	-0.730	0.465
URICA - pre-contemplation 2 – URICA - pre-contemplation 1	-2.019	**0.043**	-1.405	0.160	-0.052	0.959	-0.285	0.775
URICA - contemplation 2 – URICA -contemplation 1	-1.239	0.215	-0.657	0.511	-0.770	0.441	-0.915	0.360
URICA - action 2 – URICA - action 1 -	-1.846	**0.065**	-2.102	**0.036**	-0.441	0.659	-0.428	0.669
URICA – maintenance 2 – URICA maintenance 1	-2.181	**0.029**	-2.115	**0.034**	-0.727	0.467	-0.289	0.772
URICA Total 2 – URICA Total 1	-2.383	**0.017**	-0.803	0.422	-0.640	0.522	-0.598	0.550

7. Discussion

Results obtained to date are only preliminary and subject to much further analysis and refinement. However, some general considerations can be made on the basis of these outcomes. In the following paragraph, data will be discussed separately for the BED and Obese samples.

7.1 Binge Eating Disorder sample

Pre-post treatment comparison revealed several interesting changes both at psychologicaland physiological level. State Anxiety (STAI X2) significantly decreases in both Experiential Cognitive Therapy (ECT) (Main before: 49,44; Main after: 36,77; *p*: 0,018) and Nutritional (NT) conditions, (Main before: 49,77; Main after: 38,77; *p*: 0,013), while no significant changes are evidenced in Cognitive-Behavior Therapy (CBT) condition. On the other hand, Anxiety of patients assigned to the Waiting List (WL)

condition significantly increases from initial levels (Main before: 52,33; Main after: 61,88; *p*: 0,044).

Depression levels (BDI) significantly decrease in both ECT (Main before: 22,23; Main after: 8,11; *p*: 0,008) and CBT (Main before: 20,55; Main after: 12,11; *p*: 0,050); however, complete remission of depressive symptoms is observed only in the ECT group.

Improvement of Self-Esteem levels (RSE) is significant in all groups, with the exception of WL. This suggests that being involved in rehabilitation program increases self-esteem independently of the kind of treatment that patients undergo.

Positive changes of Assertive Behaviors (RAS) are observed in ECT only. This confirms the assumption that virtual simulation of real situations allows to improve patient's social skills.

DIET and WELSQ pre- and post-treatment comparisons revealed that eating control and eating self-efficacy significantly increase in all conditions (with the exception of WL).

This emphasizes the importance of nutritional course underwent by all subjects during the in-patient phase. Significant reduction of binge eating episodes (see Tab. 7) further confirms this assumption. However, it should be noted that the entity of change, as far as DIET levels are concerned, is greater in ECT than in control groups. This suggests that Virtual Reality can play an important role in treating eating control diseases.

Moreover, the observation that WELSQ values are generally greater in ECT than in CBT indicates that ECT is more effective than CBT in increasing self-efficacy levels.

Also, ECT is more effective than CBT in improving body image (BIAQ – BSS – CDRS): in particular, ECT increases body awareness, body satisfaction and physical acceptance and makes patients confident about the possibility of further progresses.

The analysis performed on CDRS revealed significant shifts in the Real Body scale in both ECT and CBT conditions at the conclusion of the in-patient phase. Most likely, awareness of weight loss increased patients' body satisfaction and body perception. In addition, patients undergoing ECT and CBT might have benefited by the participation to psychological groups. In these groups, in fact, the topic of self-esteem related to body awareness has been extensively discussed. As a confirmation of this, weight loss (see Tab. 5) is significant in ECT, CBT and NT conditions, while mean weight significantly increases in WL (no treatment condition).

7.2 Obese sample

Also for the obese group, pre-post treatment comparison revealed relevant changes both at psychological and physiological level. State Anxiety (STAI X2) significantly decreases in ECT (Main before: 38,82; Main after: 32,41; *p*: 0,038), in CBT (Main before: 43,29; Main after: 37,17; *p*: 0,012), and in NT (Main before: 38,29; Main after: 32,76; *p*: 0,020), while no significant changes are evidenced in WL condition.

Depression levels (BDI) significantly decrease in both ECT (Main before: 13,05; Main after: 6,23; *p*: 0,001) and CBT (Main before: 17,64; Main after: 10,29; *p*: 0,010); however, complete remission of depressive symptoms is observed only in the ECT condition.

Improvement of Self-Esteem (RSE) is significant, but only in the ECT (Main before: 6,70; Main after: 8,47; *p*: 0,003) and BCT conditions (Main before: 5,35; Main after: 7,70; *p*: 0,015). This supports the assumption that being involved in an intensive psychological rehabilitation program has a positive effect on self-esteem.

Positive changes of Assertive Behaviors (RAS) are pronounced in ECT, confirming the assumption that virtual simulation of real situations allows to improve patient's social skills. Assertive Behaviors improves in BCT as well, underlying the therapeutical added value of psychological group discussions.

Table 8. Physiological changes between the start and the end of the treatment in the OBESE Group
(Z: Wilcoxon non parametric test; significant values are marked in bold font)

	Experiential Cognitive Group		*Cognitive Behavioral Group*		*Nutritional Group*		*Waiting List*	
Physiological data	*Before*	*After*	*Before*	*After*	*Before*	*After*	*Before*	*After*
Weight	111.4+/-16.4	104.14+/-15.25	109.6+/-10.3	101.5+/-9.9	109.8+/-16.7	102.27+/-15.38	110.3 +/-13.9	111.1 +/-13.8
	Z	*p*	*Z*	*p*	*Z*	*p*	*Z*	*p*
	-3.62	**0.000**	-3.621	**0.000**	-3.62	**0.000**	-1.633	0.102
Body Mass Index	40.83+/-4.54	38.17+/-4.07	42.1+/-5.9	39.0+/-5.3	40.6+/-4.8	37.8+/-4.4	40.6 +/- 4.3	40.9 +/- 4.1
	Z	*p*	*Z*	*p*	*Z*	*p*	*Z*	*p*
	-3.621	**0.000**	-3.621	**0.000**	-3.621	**0.000**	-1.664	0.096
Hips width	43.3+/-3.4	41.97+/-3.41	44.8+/-2.6	43.0+/-2.7	43.1+/-3.9	41.1+/-3.5	no data	no data
	Z	*p*	*Z*	*p*	*Z*	*p*	*Z*	*p*
	-3.429	**0.001**	-3.448	**0.001**	3.550	**0.000**	no data	no data

Table 9. Behavioral changes between the start and the end of the treatment in the OBESE Group
(Z: Wilcoxon non parametric test; significant values are marked in bold font)

	Experiential Cognitive Group		*Cognitive Behavioral Group*		*Nutritional Group*		*Waiting List*	
Physiological data	*Before*	*After*	*Before*	*After*	*Before*	*After*	*Before*	*After*
Binge	1.8+/-4.9	0.0	0.5+/-1.5	0.0	0.5+/-1.1	0.0	1.7+/-4.0	0.4+/-1.1
	Z	*p*	*Z*	*p*	*Z*	*p*	*Z*	*p*
	-1.890	0.059	-1.633	0.102	-1.841	0.066	-1.826	0.068
Vomiting	0.0	0.0	0.00	0.00	0.1+/-0.5	0.0	0.2+/-0.7	0.2+/-0.7
	Z	*p*	*Z*	*p*	*Z*	*p*	*Z*	*p*
	0	1	0	1	-1.000	0.317	0.447	0.6555
Laxative	0.0	0.0	0.9+/-3.9	0.0	0.0	0.0	0.0	0.0
	Z	*p*	*Z*	*p*	*Z*	*p*	*Z*	*p*
	0.0	1	-1.000	0.317	0	1	0	1
Physical activity	2.88+/-2.02	3.17+/-1.70	2.3+/-1.8	3.5+/-1.6	2.8+/-2.0	3.3+/-1.4	2.8+/-1.9	2.6+/-1.8
	Z	*p*	*Z*	*p*	*Z*	*p*	*Z*	*p*
	-0.794	0.427	-2.218	**0.027**	-1.341	0.180	-0.7	0.4

The group, in fact, reproduces a similar circumstance but it is protected: patient can practise and then go out "in the open". During the group meeting, assertive, passive and aggressive interactions can develop among patients who can provide real situations to work on and experiment the assertiveness on various kind of people to apply these behaviours outside the group.

Results of analysis conducted on DIET and WELSQ data reveal that in all conditions (with the exception of WL) patients' eating control and self-efficacy are significantly strengthened. This emphasizes the positive effect of the nutritional course carried out during the in-patient phase. However, it should be noted that the entity of change, as far as DIET levels are concerned, is greater in ECT than in control groups. This finding is the same of BED group and is consistent with the assumption that Virtual Reality can play an important role in treating eating control diseases. Also, the observation that WELSQ values are generally higher in ECT than in CBT indicates that ECT is more effective than CBT in increasing self-efficacy levels.

ECT is more effective than CBT in improving body image (BIAQ – BSS – CDRS): in particular, ECT increases body awareness, body satisfaction and physical acceptance and is in agreement with findings of BED group. The analysis performed on CDRS revealed significant shifts in the Real Body scale in ECT, CBT and NT conditions at the conclusion of the in-patient phase. The most reasonable explanation of this change is the awareness of weight loss, which increases patients' body satisfaction and body perception.

Motivation to change is greater in ECT and CBT than in NT and WL. This further supports the assumption that being involved in an intensive psychological rehabilitation program increases therapeutical compliance independently of the kind of treatment that patients undergo.

7.3 General discussion

By clinical reputation, eating disorders are some of the most frustrating and recalcitrant forms of psychopathology. As noted by Vitousek et al. [41]: "Few symptom patterns evoke stronger reactions from professionals and none may require more forbearance and self-questioning to manage... [These] disorders are unpopular with clinicians because of the perception that clients habitually deny, deceive and rationalize to protect their symptomatology" (pp. 391-392). This is mostly owed to the strong resistance to change that characterises eating disorders patients, mainly anorectic and bulimic ones.

The first obtained result is the significant change induced by the treatment on the body image of the patients. ECT produced a significant change in the body image, usually associated to a reduction in problematic eating and social behaviors. Actual body-image treatment involves a cognitive/behavioural or a visuomotor therapy that needs many sessions. The possibility of inducing a significant change in body image and its associated behaviors using a short-term therapy can be useful to improve the efficacy of the existing approaches. As such, the procedure can be considered as a comprehensive treatment package to break through the "resistance" to treatment in clinical subjects [157].

Second, using ECT, therapists were able to improve the motivation for change in clinical sample. According to Prochaska and DiClemente [109] it is possible to identify five stages of change that people face in replacing problematic behavior. These stages can be considered predictable and stable subprocesses within the therapeutic process.

The five stages are: Precontemplation, Contemplation, Determination, Action and Maintenance/Relapse.

Particularly, a stage of change is critical for therapy of eating disorders: Contemplation. Contemplation is a paradoxical stage of change, since the patient is open to the possibility of change but is stopped by ambivalence. The characteristic style of the

contemplator is, "yes, but . . .". Two key techniques are usually in facilitating a shift from the contemplation stage to the determination stage of change [110]. The first technique is the use of the *miracle question*, a typical approach used by the solution-focused brief therapy [110, 111]. The miracle question is used to help the client identify how her life would be different if her eating disorder were miraculously gone. The second technique is the search for exceptions: situations in which the patient has been able to manage the problematic eating behaviours more successfully. Using the VR sessions to experience the effects of the miracle and the successful situations, the patients gained an awareness of her need to do something to create change but also to experience a greater sense of personal efficacy.

VR also appeared to be well suited to the Socratic approach. In fact, VR immerses the patient in a real-like situation that she/he is forced to face. The advantages of a VR-based Socratic method are clear. It can minimize distortion in self-report, since there is no script for conforming clients to parrot or oppositional clients to reject. Moreover, it circumvents power struggles because the therapist can be invisible to the patient and presents no direct arguments to oppose. Finally, evidence is more convincing and conclusions better remembered because they are one's own.

Change often requires the recognition of the distinction between an assumption and a perception [70]. Until revealed to be fallacious, assumptions constitute the world; they seem like perceptions, and as long as they do, they are resistant to change. By using VR, the therapist can actually prove that what looks like a perception doesn't really exist. Once this has been understood, individual maladaptive assumptions can then be challenged more easily. As underlined by social cognitive theory, performance-based methods are the most effective in producing therapeutic change across behavioral, cognitive, and affective modalities [158]. In fact, the proposed experiential approach could help patients to discover that difficulties can be defeated, so improving their cognitive and behavioral skills for coping with stressful situations.

The final interesting result is the lack of side effects and simulation sickness after the experience in the virtual environment, confirming the possibility of using virtual environments in ECT. As such, the use of VR sessions might help as a part of a comprehensive treatment package to break through the "resistance" to treatment in clinical subjects [157, 159]. We assume that the virtual experience might be useful to achieve these goals, not as a magic trick but as a catalyser in a therapeutic process.

In summary, results of the small clinical trial show that the virtual simulation of demanding "real-life" situations is useful to improve patient's awareness, body satisfaction, eating control, social skills, self-esteem and motivation to change. In particular, pre-treatment/post-treatment comparison seems to indicate that Experiential Cognitive Therapy was more effective than traditional approaches in the treatment of Obesity and Eating Disorders (Cognitive-Behavior Therapy and Nutritional Course). However, since a limited number of subjects was tested in a relatively high number of conditions, statistical power of the contrasts was reduced. For this reason, clearer indications regarding the relative effectiveness of the treatments are expected from large-scale clinical trials.

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8 Male Sexual Dysfunctions: immersive Virtual Reality and multimedia therapy

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Abstract The study describes a therapeutic approach using psycho-dynamic psychotherapy integrating virtual environment (VE) for resolving impotence or better erectile dysfunction (ED) of presumably psychological or mixed origin and premature ejaculation (PE). The plan for therapy consists of 12 sessions (15 if a sexual partner was involved) over a 25-week period on the ontogenetic development of male sexual identity, and the methods involved the use of a laptop PC, joystick, Virtual Reality (VR) helmet with miniature television screen showing a new specially-designed CD-ROM programs using Virtools with Windows 2000 and an audio CD. This study was composed of 30 patients, 15 (10 suffering from ED and 5 PE) plus 15 control patients (10 ED and 5 PE), that underwent the same therapeutic protocol but used an old VR helmet to interact with the old VE using a PC Pentium 133 16Mb RAM. We also compared this study with another study we carried out on 160 men affected by sexual disorders, underwent the same therapeutic protocol, but treated using a VE created (in Superscape VRT 5.6) using always Windows 2000 with portable tools. Comparing the groups of patients affected by ED and PE, there emerged a significant positive results value without any important differences among the different VE used. However, we had a % increase of undesirable physical reactions during the more realistic 15-minute VR experience using Virtools development kit. Psychotherapy alone normally requires long periods of treatment in order to resolve sexual dysfunctions. Considering the particular way in which full-immersion VR involves the subject who experiences it (he is totally unobserved and in complete privacy), we hypothesise that this methodological approach might speed up the therapeutic psycho-dynamic process, which eludes cognitive defences and directly stimulates the subconscious, and that better results could be obtained in the treatment of these sexual disorders. This method can be used by any psychotherapist and it can be used alone or associated with pharmacotherapy prescribed by the urologist/andrologist as part of a therapeutic alliance.

1. Introduction

Regarding the reason for our investigations into male sexuality, some bare statistics should be borne in mind. Briefly summarised: in Italy [1] 12.8% of the male population suffers

erection dysfunction (ED) commonly referred to as "a persistent or recurrent inability to attain, or to maintain, until completion of sexual activity, an adequate erection" [2]; an estimate based on the examination of 1700 non-hospitalized males in the U.S. indicates that approximately 18 million Americans suffer from the same dysfunction [3], and approximately 5 to 20% of men in the world have moderate-to-severe ED [4] and this sexual problem increases with age and co-morbidity [5]. Available statistical data suggest that 70% of erectile dysfunctions can be attributed to organic causes, while the remaining 30% is due to psychogenic or mixed causes [6]. Even if we diagnose that the primary cause of sexual dysfunction is organic, we must also consider that a psychogenous component is always present thus contributing to maintain a vicious circle. In fact primary and secondary psychological elements may both be hidden in the innermost recesses of the impotent patient's mind.

What are the conventional therapies in use? As a rule, often only after conventional therapies have been tried (pharmacotherapy, intracavernous injections, vacuum therapy) are patients advised to seek the help of a psychotherapist. Today, oral medication is regularly prescribed, often by family and general practitioners in the primary care setting [7], because the patient often prefers a simple and, above all, immediate successful treatment [8], although this may be at the expense of accurate patient assessment [9]. Recent news about the rush to get Sildenafil to take care of impotence indicates a sizeable mass phenomenon (there is however a dropout rate of about 45% after 18 months in previously untreated ED) [10]. International clinical reports on the subject tell us that between 30% and 50% of those undergoing intracavernous injection eventually abandon therapy before its completion [11,12,13].

Moreover, it's estimated that about 75% of men at some time or other in their sexually active lives have suffered from Premature Ejaculation (PE) commonly referred to as: "a persistent or recurrent onset of orgasm and ejaculation with minimal sexual stimulation before, upon, or shortly after penetration and before the person wishes it" [14].

An American study of 1994 [15] estimates that 29% of men suffer from this disturbance. PE is undoubtedly a more wide-spread phenomenon than has been hitherto assumed. The statistical data mentioned above clearly indicate the alarming size of the problem, as well as the obstacles which medicine must overcome in dealing with it adequately. The natural sense of shame which afflicts individuals affected by these pathologies is probably the reason why only a fraction of cases is brought to medical attention. Impotence and premature ejaculation cause a loss of self-esteem, and may lead the patient to a clinically depressed condition, putting a strain on his relationship and having an impact on his quality of life. The use of pharmacotherapy alone to resolve these problems is sometimes akin to the use of a mere aphrodisiac which stimulates and enhances sexual performance thus giving the impression of having resolved any problems which may exist between the sufferer and his partner.

The idea of using virtual technology came to us several years ago in London, after trying out some first-generation video-games just for fun. The impression we got from that chance experience was one of total involvement: the passage of time and the surrounding reality became irrelevant while the immediacy of the virtual reality was more intensely experienced. In other words, one starts taking part in a dynamic reality, having the real sensation of living a new, concrete experience. We took our first steps by combining a Virtual Reality (VR) experience with the method we were already using for the treatment of male sexual disturbances: the pre-existing method had already included an audio element, and thus the innovation (the inclusion of an audio-*visual* element) was as simple and immediate as connecting already existing electric wires. The dark space was lit up; what was a hitherto partial view was now complete. Then we devised a specially-designed VR program integrating previous experiments into a cycle of therapy that was both more

wide-ranging, as well as more precisely targeted. Along with the new technological support, the psychotherapy sessions remained unaltered but were integrated with VR. The innovation was that using multimedia immersion therapy (i.e. VR), the treatment of male sexual dysfunctions following a therapeutic programme is (a) repeatable; (b) focuses on the ontogenetic development of the male sexual identity and (c) can be utilized by any psychotherapist, psychologist or medical doctor.

2. The therapeutic protocol and its clinical rationale

This treatment is an evolution of the first sex therapy proposed by Masters and Johnson [36,37] and also takes into account the new, advanced theories of Kaplan [38], Stoller [39], Money [40], Schaffer and Emerson [41], Bowlby and Ainsworth [42,43] and Baldaro Verde Verde [44,45].

The treatment follows the hypothesis that sexual identity, which is defined by a multi-factor concept, is acquired in the earliest years of life through a process of identification with the same-sexed parent and is completed by the parent of the opposite sex. It is only consolidated at the end of an often difficult, complex process which includes a fusion of biological, psychological and social elements in a dynamic continuum. The evolving aspect lies in the temporal order in which gender identity, social role and aim emerge. The dynamic aspect involves the risk of one of the pillars of sexual identity being damaged or even destroyed. Therapy is required in such cases: sexual identity must be rebuilt and symptoms decoded (in our opinion this is also true for cases of organic ED in that the sexual dysfunction can spark off and sustain a vicious circle). In this critical process, the VR method rapidly enables the patient to evoke memories and emotions that are worked through with the psychotherapist at the end of the session whilst the patient is still under the influence of the interactive experience, thus accelerating the process of working through events and sensations personally. This allows the patient to enter the sphere of associations of sexual dysfunction which takes much longer when only conventional psychotherapy sessions are used. Indeed, traditional psychotherapy primarily privileges the use of words, and if used alone, normally requires long periods of treatment in order to resolve sexual dysfunctions. We hypothesized that our methodological approach could speed up the cure for sexual disorders, accelerating the psychodynamic process, overcoming cognitive barriers in the patient and directly engaging his unconscious. This type of psychotherapy takes into consideration both the immediate and the more remote causes of sexual dysfunction both in the male and in his relationship with his partner. The cycle of treatment takes place over 15 sessions and is a form of sexual therapy which falls within the accepted confines of short-term psychodynamic psychotherapies. After a urological/adrological examination, we used a therapeutic protocol for the treatment of male sexual dysfunctions which consists of 12 sessions of psychotherapy each lasting 45 minutes (plus 3 additional sessions involving the patient's sexual partner, if any). The cycle of treatment takes place over a period of six months and uses the new Virtual Reality technology employing a VR headset, a computer and a joystick. After a sexological diagnosis (a decoding of sexual symptoms), the psychotherapy (with integral use of VR) facilitates the objective (i.e. non-interpreted) installation of a positive transference, attempting to remove pre-existing adaptive defences and looking to restructure the sexual identity of the patient - including his perception of himself and his view of his role and position in society - in order that the patient might come to understand the process by which his sexual dysfunction has been created and perpetuated. The objective being to consider, contrasting both the signs of anxiety and the mechanisms which induce us to

control instinctive behaviour, crises during the critical periods in the life of the male. Such crises come from the interaction of a series of factors (biological, cultural and personal).

Our therapeutic protocol tries to find pre-existing connections through those "windows on the past" of the male sexual development corresponding to the critical periods of major change – infancy, puberty, adolescence. In the course of the therapy, the patient from the start re-elaborates and subsequently reconstructs an ideal image of infancy, via the virtual experiences and discussions with the psychotherapist, which becomes a safe virtual base from which he can confront "the other". In practice, session after session, the patient relives symbolical "key moments" on his journey - from infancy through adolescence to adulthood – to create a secure sexual identity. We consider that the creation of secure sexual identity retains a positive emotional value over time, probably due to the fact that it forms a mental reference model.

From the assumption that, as Joseph LeDoux puts it [16], the unconscious mind is able to operate more fluidly in non-verbal modes, and for each emotional module there is a corresponding neuronal line which allows its functioning, such as in the case of laughter or fear. Coherently with these assumptions, the application of VR treatment, which uses images and involves the subject emotionally, can stimulate new mental associations in a sort of reality-monitoring meant as "a way of referring to the activity of discriminating between memories primarily derived from external events and those primarily derived from internal events" [17]. On the basis of Erik Kandel's studies on the Californian sea snail, *aplysia californica* [18,19], of the studies regarding the functioning of the big brain gene of *drosophila* [20], and considering also research on the cortical reorganisation of monkeys [21,22], and in socially dominant or subordinate crayfish [23], in which both adaptations as well as certain types of stimulation can cause changes in neuronal functioning, we may, therefore, dare to affirm that, using this therapeutic protocol, it is possible to make changes in functional metabolic activity in specific areas of the brain probably connected with the erection mechanism, (a finding confirmed by tests performed using brain PET done before and after therapy) [24,34]. VR enables the patient rapidly to develop memories and emotions that are worked through with the psychotherapist at the end of the session while the patient is still under the influence of the interactive experience. This accelerates the process of working through events and sensations, allowing the patient to enter the sphere of associations of sexual dysfunction, which requires much more time when only psychotherapy is used. Moreover, during the virtual experience, the patient follows pathways that accelerate a psychodynamic process: VR experience eludes cognitive defences and directly stimulates the subconscious, hence also everything related to the patient's experience in the sexual sphere. The obstacles that lead to sexual dysfunction are thus brought to light. As the patient becomes aware that the causes of his sexual dysfunction can be modified, he acquires, under the therapist's guidance, a further means of taking part in the healing process. We suggest, on the basis of the neuro-psychological work of Damasio [35,47], that by interacting with his own senses through VR, the patient generates inputs that act on phylogenetically lower brain centres through the neocortex to modify certain associations. Disinhibition of the sex drive, in the Freudian sense [26], is the probable result. Preliminary studies made by our group showed that the positive results of this approach were lasting: this suggests that this method accelerates the healing process by re-opening old brain pathways or consolidating and implies that new and rarely-used inter-synaptic connections, characterized by a particular magnitude of activation [27], may be established so that new mnemonic associations favouring satisfaction of natural drives can flow.

All patients in the groups received psychotherapeutic treatment using the *Virtual Reality-Optale Method* [30, 25]. The 12 treatment sessions are structured as follows: the first baseline session employs multimedia acoustic session, the second consist of

psychotherapy alone; then, in subsequent weeks, four multimedia acoustic sessions are alternated with six VR experiences; a final discussion is held. During the multimedia acoustic experience using words and music studied specifically for the different phases of evolution, the psychotherapist and patient (comfortably seated in a swivel chair) listen together to a recording of two voices (with background music) that describe pathways through a forest, which requires the listener to make choices regarding the situation in which he finds himself. The patient's reactions, comments and body language are noted [28] and afterwards the patient speaks to the psychotherapist about his experience. During the 15-minute VR experiences, the patient sits comfortably in a swivel chair and uses a joystick and a stereophonic head-mounted display (HMD) to interact in a Virtual environment (VE) developed using the virtual reality development kit. The subject, who wears a HMD, feels free to move as he would in the real world in complete privacy. This allows the therapist, who experiences the same virtual world on the computer monitor, to offer assistance to overcome technical difficulties when needed, through a microphone connection with the headphones inside the HMD. During the Virtual experience, the subject listens to pre-arranged background music in MP3 format through the headphones inside the helmet. The music played in the soundtracks have been created in such a way so as to try to avoid any possible personal memory of them in order to allow greater involvement both in the stories told, as well as in the pictures seen during these experiences in the virtual world. Following each listening or virtual experience, the subject was always encouraged to summarise aloud what he had been thinking.

3. Materials and methods

The investigation was conducted on 30 heterosexual males affected by sexual disorders (STUDY ONE), who had undergone no prior sexual therapy. (Another study "STUDY TWO" of 160 men affected by sexual disorders who underwent the same therapeutic protocol, but treated using a VE created (in Superscape VRT 5.6) using always Windows 2000 with portable tools. Study two is discussed below).

STUDY ONE

After collecting the subjects' medical history, a physical examination [29] and other diagnostic procedures carried out by medical staff in the Andrologic Centre, patients were assigned either to the experimental or to the control groups. **Group I** included 10 patients who had been suffering from ED for more than six months.

Group I was further divided into two subgroups:

Subgroup A = 5 patients (average age 43,4) suffering from ED presumable due to purely psychological causes.

Subgroup B = 5 patients (average age 50) suffering from ED presumable due to mixed causes (psychological and general medical condition or substance use deemed contributory but not sufficient on its own to account for the sexual dysfunction).

Group II contained 5 patients (average age 39,8) affected by primary PE.

Control Group I included 10 patients who had been suffering from ED for more than six months. This control Group I was further divided into two subgroups also:

Subgroup AI= 5 patients (average age 44,2) suffering from ED presumable due to purely psychological causes.

Subgroup BI= 5 patients suffering from ED (average age 48,6) presumable due to mixed causes (psychological and general medical condition or substance use deemed contributory but not sufficient on its own to account for the sexual dysfunction).

Control Group II contained 5 patients (average age 32,8) affected by primary PE.

Experimental groups and control groups underwent the same therapeutic protocol, but control groups were presented with the old virtual reality-based sexual treatment [30,25], while experimental groups used a completely new virtual environment, which was developed in the VEPSY project. Due to ethical reasons, no control group using traditional psychotherapy alone was included in this study, since previous investigations have already proven the greater effectiveness of the Optale Method over traditional psychotherapy alone [30,25].

All patients were given:

a. the "The International Index of Erectile Function (IIEF)" [31]. The IIEF instrument (a self-administered sexual activity questionnaire) consists of 15 items, six of which are included in the erectile function domain;
b. a generic self-evaluation questionnaire for the presence of depressive and anxiety symptoms and eventually to the "Hamilton Psychiatric Rating Scale Depression, 1993" [32].

These instruments together with the clinician's evaluation were used to assess the weight of psychological factors in the aetiology of the disturbance and to allow the exclusion of those cases whose organic pathologies were severe enough to constitute the sole cause of the sexual dysfunction. Patients suffering from major psychiatric disorder or having history of alcohol or substance abuse were also excluded from the present study.

The patients' informed consent was obtained and the method of choosing the two groups (experimental and control) at random was explained to the patients. It was also made clear that at the end of the cycle of treatment, patients assigned to the control group could undergo the new treatment if the results of the experimental group were found to be more effective than those of the control group.

Structure of the Psychological Interview:

During the interview (face to face) the therapist underlines the fact that the subject will be supported by specific psychotherapy attempting to highlight and understand the problem.

Key issues investigated are:

- Past uro-genital pathologies?
- Nocturnal bedwetting after 5 years of age?
- Does he uncover the glans to urinate or to masturbate?
- The frequency and the situational context of the sexual disorder.
- Whether it is associated with loss of desire [47] or with other sexual dysfunctions (DSM-IV, 1994).

Finally the patient is asked about prior attempts at solutions and what results he expects from the therapy.

Presentation of the therapy:

After the interview, the clinician explains the therapy schedule and shows to the patient the material that will be used.

Key points discussed are:

- How Virtual Reality and Multimedia system is used in the treatment.
- Length of the Therapy: 15 psychotherapy sessions (12 plus 3) over a period of 6 months. Each consultation lasts 45 minutes.

- Length of multimedia acoustic and Virtual Reality experience: about 15 minutes each.

4. Results

Results of STUDY ONE

Group I divided into two subgroups:

Subgroup A I – 5 patients suffering from ED presumable due to purely of psychological origin:

drop-outs: 0 cases;
improvement: 1 case (partial positive response);
resolution: 3 cases (complete positive response).
no result: 1 case;

The overall partial and complete positive responses thus amounted to 80%. A partial positive response is defined as an increase in positive results, but still less than 66% (two out of three times). We considered as drop-out cases only before the 7th session of the treatment cycle, the drop-outs after session 7 are counted as negative results. This evaluation is applied to the whole study.

Subgroup B I - 5 patients suffering from ED presumable due to mixed origin (organic and psychological):

drop-outs: 0 cases;
improvement: 1 case (partial positive response);
resolution: 1 case (complete positive response).
no result: 3 cases;

The overall partial and complete positive responses thus amounted to 40%.

Group II – 5 patients affected by primary PE:

drop-outs: 1 case;
improvement: 0 cases (partial positive response);
resolution: 4 cases (complete positive response).
no result: 0 cases;

The overall partial and complete positive responses thus amounted to 80%.

After a 25-week treatment period, the overall partial and complete positive response rate was, therefore, 67%.

Two patients reported temporary vertigo and one nausea during the first 15-minute VR experience, during subsequent VR experiences we suggested that they move in the VE more slowly.

The two groups used the new stereophonic head-mounted display to interact in the new VE, developed using the Virtools toolkit software with laptop PC with Microsoft Windows 2000.

Control Group I divided into two subgroups:

Control **subgroup A I** – 5 patients suffering from ED presumable due to purely of psychological origin:

drop-outs: 0 cases;
improvement: 2 cases (partial positive response);
resolution: 2 cases (complete positive response).
no result: 1 case;

The overall partial and complete positive responses thus amounted to 80%.

Control **subgroup B I** - 5 patients suffering from ED presumable due to mixed origin (organic and psychological):

drop-outs: 0 cases;
improvement: 0 cases (partial positive response);
resolution: 2 cases (complete positive response).
no result: 3 cases;

The overall partial and complete positive responses thus amounted to 40%.

Control Group II – 5 patients affected by primary PE:

drop-outs: 1 case;
improvement: 0 cases (partial positive response);
resolution: 4 cases (complete positive response).
no result: 0 cases;

The overall partial and complete positive responses thus amounted to 80%.

After a 25-week treatment period, the overall partial and complete positive response rate was, therefore, 67%.

Nobody reported an undesirable physical reaction during the 15-minute VR experience.

The two control groups followed the same therapeutic protocol but used the old stereophonic head-mounted display to interact in the old VE, developed using the VREAM toolkit software with a PC Pentium 133 (16 Mb RAM).

STUDY TWO

The aim of this study was to evaluate the efficiency of combined use of psycho-dynamic psychotherapy integrating VR for the treatment of ED and PE in 160 heterosexual males who had neither any prior sexual therapy not had made use (either before, during or after therapy) of any specific pharmaceuticals for the treatment of primary sexual dysfunction. All subjects had given their informed consent. After a clinical diagnosis in an andrologic center, 50 presumably purely psychological ED (average age 43.7 years), 60 mixed ED (53.9 years) and 50 primary PE (39 years) who suffered of these problems over six months were undergoing to a cycle of 12 sessions, over a 25-week period, of psychotherapy integrating an audio CD and helmet with a miniature television screens that projected specially-designed CD-ROM program, using a VE created (in Superscape VRT 5.6) using Windows 2000 with portable tools, on the ontogenetic development of male sexual identity (Optale Method).

Results of STUDY TWO

After 25 weeks of cycle of treatment, we obtained the following results:

Group IA – 50 ED presumably of purely psychological origin:

drop-outs: 5 cases (10%);
improvement: 13 cases (26%) (partial positive response);
resolution: 25 cases (50%) (complete positive response).
no result : 7 cases (14%).

(A partial positive response was defined as an increase in positive results, but still less than 66% (two out of three times). We considered as drop-out cases only before the 7th session of the treatment cycle, the drop-outs after session 7 are counted as negative results.This evaluation was applied to the whole study).

The overall partial and complete positive responses thus amounted to 76 %.

Group IB – 60 ED of mixed origin (organic and psychological):

drop-outs: 10 cases (17%);
improvement: 8 cases (13%) (partial positive response);
resolution: 19 cases (32%) (complete positive response);
no result: 23 cases (38%).

The overall partial and complete positive responses thus amounted to 45%.

Group II – 50 primary PE:

drop-outs: 13 cases (26%);
improvement: 4 cases (8%) (partial positive response);
resolution: 24 cases (48%) (complete positive response).
no result: 9 cases (18%).

Two patients reported nausea and one, vertigo during the first 15-minute VR experience during the first viewing.

The overall partial and complete positive responses thus amounted to 56 %.

After a 25-week treatment period, the overall partial and complete positive response rate was, therefore, 58%.

5. Statistical Analysis

STUDY ONE
Loglinear Model 1

30 subjects were involved in the study and were subdivided into two groups (control and experimental). Following therapy, the results set out in the Table 1 were observed.

To analyse this table, we consider three variables (Result (R), Pathologies (P) and Group (G)) and used the following loglinear model:

$$\log m_{ijk} = \mu + \lambda^{R} + \lambda^{RG} + \lambda^{RP}$$

$\log m_{ijk}$	represents the logarithm of the expected frequency in cell *ijk*;
μ	represents the main effect;
λ^{R}	represents the effect of Result;
λ^{RG}	represents the interaction between Result and Group;
λ^{RP}	represents the interaction between Result and Pathology;

Table 1. Results of the Study One

			pathologies			Total
GROUP			**Subgr A I**	**Subgr B I**	**Group II**	
control	**RESULT**	positive	2	2	4	8
		Partially pos.	2			2
		drop out			1	1
		negative	1	3		4
	Total		5	5	5	15
experimental	**RESULT**	positive	3	1	4	8
		Partially pos.	1	1		2
		drop out			1	1
		negative	1	3		4
	Total		5	5	5	15

The Likelihood Ratio [33] was equal to $G^2 = 2.27$ (df 8, $p = 0.97$) which shows a good fit to the model used. None of the parameters, however, was significant.

The lack of effects could be attributed to the small number of subjects involved. As can be seen in the table, the frequency distribution is almost equal in the two groups (control and experimental).

Loglinear model 2
STUDY ONE plus 15 patients selected at random from STUDY TWO

From a sample of 160 patients (STUDY TWO), 15 patients who were of similar age to the previous sample (STUDY ONE) were randomly pooled and subdivided into three groups.

The results set out in the Table 2 were observed.

Table 2. Results of the Study Two

			pathologies			Total
GROUP			**Subgr A I**	**Subgr B I**	**Group II**	
control	**RESULT**	positive	2	2	4	8
		Partially pos.	2			2
		drop out			1	1
		negative	1	3		4
	Total		5	5	5	15
experimental	**RESULT**	positive	3	1	4	8
		Partially pos.	1	1		2
		drop out			1	1
		negative	1	3		4
	Total		5	5	5	15
15 from sample of 160	**RESULT**	positive	2	2	1	5
		Partially pos.	1	1		2
		drop out	2		3	5
		negative		2	1	3
	Total		5	5	5	15

Table 3. Estimated parameters in the loglinear model

		lamba	s.e.
RESULT	positive	2,061	1,227
	Partially pos.	-7,393	27,059
	drop out	2,572*	1,225
	negative	0,000	,

In the table 2, the results from the previous analysis are repeated. Again, we can see that the result fits well with the model used: $\mathbf{G^2} = 9{,}84$ (df 16, p = 0,87).

From subsequent analysis of the parameters emerged a significant value in relation to effect R. Moreover, as we can see from a reading of the table of estimated parameters relative to effect R, and using the category "negative" as the reference category, the parameter relative to "drop out" is statistically significant.

We must point out that the parameter relative to "partially positive" gives rise to a standard error which is very high.

6. Discussion

The aim of this study, which follows on from our earlier research on VR use integrating the psychotherapy for the treatment of ED [30] and PE [25], was to evaluate the therapeutic efficiency of this method - which uses a repeatable therapeutic protocol – using a more realistic VE and to discern if the more realistic VE could increase the positive results. The percentage of positive results obtained from all samples supports the combination of this psychotherapeutic method integrating VR for curing the process of male sexual dysfunctions (ED and PE). Furthermore, this method could accelerate the healing process favoring a rapid solution of the sexual problem leading to a satisfactory sexual performance. Regarding the necessity of integrating the pharmacotherapy with psychotherapy for the treatment of ED, we agree completely with Levine who says: "We increasingly recognise that ED usually arises from a mix of organic and psychogenic causes, yet management of this condition too often neglects the complexity of most cases of ED. While therapy with sildenafil and similar investigational drugs can play an important role in many cases of ED, physicians should recognise and try to address the psychological and interpersonal context in which ED exists in their patients"[9].

Through the VR experience which uses audio and visual schemes preceded by verbal narratives, we can generate new imaginary scenes, stimulating the long-term memory and activating the consequent logical deductions. The patient, while undergoing the VR experience, feels not only free to interact with the virtual world with the sensation of not being observed, but the patient also feels free to remember facts and events (also unpleasant). In the immediately following sessions with the psychotherapist – carried out while the patient is still "fresh" from his VR experience - the virtual reliving of such remembered events form the basis for deeper investigation. It is not necessary that the VR image and that coming from our long term memory be exact matches. The brain, as well as being able to fix for prolonged intervals an image in the absence of the object it represents, has the ability to extend and enrich this information with greater background detail, thus developing a representation of reality much more complex and articulate than the relatively primitive input would suggest.

Comparing the groups of patients affected by ED and PE did not illuminate any significant differences between them. However, the group of patients affected by PE who

underwent the therapeutic cycle using the Virtool's VE (more realistic and more fluid VE) showed a increase in positive results with respect to the 15 from sample of 160 patients who used the Superscape VE. This percentage of positive results could be due to the fact that we may have fortuitously found a group of men who were highly motivated to solve their sexual problems and who also had very understanding partners. However, with the Virtools VE, we noticed an increase in the percentage of negative physical side-effects (nausea and vertigo) perhaps as a result of the greater realism of the virtual environment and the opportunities it affords for greater fluidity of movement. Negative side-effects observed during the VR experience were very rare and took the form of feelings of nausea or vertigo during the first session under the HMD. Gradually, as treatment continued, these feelings disappeared. Indeed, patients frequently expressed a strong wish to prolong the VR sessions beyond their 15-minute span.

Modifying and enriching in some way the mental map, we can think of determining also functional changes in metal associations regarding the sexual dysfunction. Revisiting our experiences according to this protocol, we can hypothesise that some synaptic connections are facilitated, probably modifying the magnitude of such connections and that certain intersynaptic connections are favoured. In that our memory of events is inexact, fluid and is susceptible to change and adaptation (above all when our emotions are involved), we could hypothesise that VR therapy can modify long-term memory due to its apparent effect on the emotions.

The identification of those patients who could derive greater benefit from the use of this method (using Virtools development kit integrated with pharmacotherapy at a precise moment in the therapeutic cycle) is to be the subject of future investigations as part of a therapeutic alliance.

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SECTION III

CYBERTHERAPY TECHNOLOGY: ADVANCED TOOLS FOR CLINICAL PSYCHOLOGY

We contend that the use of technology does not require changes in basic clinical principles and practices: E-therapy does not modify theories, techniques, and methods typical of each approach (psychoanalytic, systemic, cognitive, behavioral, interpersonal, strategic, etc.) but could affect the level of communication and thus the possible relationship and alliance between the therapist and the patient. A psychotherapist, regardless of theoretical orientation, can move from the traditional face-to-face setting to an environment based on Internet tools. Basic techniques, such as cognitive reframing or discussion about particular feelings and emotions, can be used in this new medium, which differs from the old only in terms of novelty. Old (and functional) practices can be used through new (and promising) media. Therefore, in e-therapy, the focus of the treatment does not shift into technology but remains on the traditional process of psychotherapy.

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9 New Technologies for Providing Remote Psychological Treatments

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Abstract. New technologies lead us to a series of new applications that we could not imagine just a few years before.
Many services have appeared for Internet, the global computer network: FTP, e-mail, World Wide Web... Psychological treatments are one of the multiple applications that can be developed using these tools. Dynamic web pages that include information prepared by the therapist for different patients and that receive information from them can be generated. Other tools such as e-mail or chats can be used to provide a direct communication.
Databases can be integrated in web applications for storing data about different patients. Several formats can be used for storing the information, and some of them such as XML provide a promising method of psychological data standardization.
Using different development tools, virtual environments can also be generated and integrated in web pages, so new psychological treatments such as virtual environment exposure are also possible from web applications.
This entire basis provides the structure that allows that new applications can be imagined and developed. In a few years, new trends will appear, probably one of them will be the use of wireless devices to provide psychological treatment and help at any place and any time.

1. Introduction

In recent years, new technologies have shown their utility in different fields: business, learning, medicine and also psychology.

Employees of a company can communicate with others located in different cities, countries or continents only making use of common tools such as e-mail or more sophisticated ones such as videoconference.

Many companies have also developed e-learning strategies, so employees can learn skills required for their work only by connecting to a webpage that will present them the required information in a dynamical way, and also track their responses and possible improvements. These e-learning strategies are not only restricted to internal learning processes, but more and more they are becoming available for the general public. Taking into account new tendencies in education, they will become a common tool for academic purposes, especially in universities.

Medicine is another increasily important field of application. Doctors and nurses can use telemedicine systems to track physiological data from patients that are located far away from the hospital. This is especially interesting for countries where there are no facilities for people who live in the countryside to move to big cities where hospitals are

usually placed, and also for old people who find difficult going to a hospital away from their home in a regular way.

Finally, the last application we have mentioned in this introduction is psychology. This is a novel field of application of new technologies, but recently many remote applications for psychological treatments have appeared and it seems that the tendency in following years is that new and more sophisticated applications will be used. Telepsychiatry or telepsychology have been defined as "the use of telecommunication technologies to put in contact patients with health professionals in order to accomplish tasks such as medical or psychological diagnoses, education, treatment, consultations, transmission and storage of the patients' medical stories and data, research and other activities related to the provision of health care" [1]

The purpose of this chapter is to give an overview of the technologies that are available and how they are being used (or can be used in near future) for providing remote psychological treatments.

We will finish this introduction describing some basic concepts about networks and broadband technologies, which are the basis over which we can build applications that communicate remote places.

1.1 Basic concepts about networks

A computer network is a set of systems and services that allows transferring information between user processes that are run in independent computers. The network is composed not only by its physical part (hardware) but also by software layers that are built over this hardware and that control that information is exchanged between processes following some rules that have been defined.

Depending on the geographical extension of the network, we can distinguish between:

- Wide area network (WAN). The extension is higher than 10 Km.
- Local area network (LAN). The extension is less than 10 Km. They are usually destined for private use.
- Metropolitan area network (MAN). They can communicate different industrial nuclei. Their maximum extension is 50 Km.

For WAN, transmission velocities are in the range of kbps. In LAN and MAN, velocities are in the range of Mbps or even higher.

The common case is that a computer on a network will need to communicate with a computer on another network. In order to allow that, those networks will have to be connected either directly or indirectly through another network [2]. Joining different networks, we can have a network of networks, so any computer of a network can communicate with any computer that is located in any of the networks. There is a special network of networks that is the Internet. Internet has become so large that networks all over the world are part of Internet.

In other to allow the communication between networks, some common rules have to be followed. We define a protocol as the special set of rules that end points in a telecommunication connection use when they communicate. On Internet, a there is a set of basic communication protocols that are used: TCP/IP (Transmission Control Protocol/Internet Protocol). When one computer connects to the Internet, all the software required to control that TCP/IP rules are followed should be installed in order to be able to send and receive messages.

The higher layer, TCP, controls the division of a message into smaller packets that are transmitted over the network and received by a TCP layer on the other side that reassembles them. The lower layer, IP, controls the address part of each packet to guarantee that it arrives to the right destination. [3]

We can find the origins of the actual Internet in the late 1960s. DARPA (Defense Advanced Research Projects Agency) [4], which is the independent research branch of the U.S. Department of Defense, started a project for interconnecting computers at four university research sites. In 1972, this network (now called ARPAnet) had grown to 37 computers. The evolution of this network and technologies related to it, including TCP/IP protocols, led to the Internet that we use today.

1.2 Broadband technologies

In order to achieve that different applications such as e-learning, telemedicine or telepsychology become available to the general public it is required that most people have access to Internet, but this is not true for all countries. Moreover, for many applications it is not enough that people have an Internet connection, but it is also required that the user has a high bandwidth connection. "The real possibility of starting telemedicine or telepsychology systems was restricted until recently because of the cost of the equipment and the lack of adequate infrastructures regarding telecommunications" [5].

In this section, we are going to describe some of the broadband technologies that are becoming available to more people in developed countries, so they will allow more diffusion of telepsychology systems.

When we use a modem to connect to Internet, we use analog transmission over copper wires, and this transmission only uses a reduced portion of the maximum bandwidth. However, other technologies [3] have appeared that try to obtain a more optimum use of the bandwidth available with copper wires.

ISDN (Integrated Services Digital Network) is based on the concept of integrating both voice data (analog) with digital data over the same network. There is not analog transmission over copper wire, it is entirely digital. It is widely available in urban areas in the United States and Europe, both for home and business markets. ISDN requires that both the user and the telephonic central install an adapter. It can provide a bandwidth up to 128 Kbps, so it is suitable for transmitting high quality graphics through the network.

There are two possible levels of the service:

- Basic Rate Interface (BRI): it consists of two 64 Kpbs B-channel (data, voice and other services) and one 16 Kbps D-channel (control information).
- Primary Rate Interface (PRI): it consists of 23 B-channels and one 64 Kbps D-channel in the United States or 30 B-channels and 1 D-channel in Europe.

The first kind of service is most suitable for home and small businesses.

DSL (Digital Subscriber Line) includes a set of technologies that are used to deliver high-bandwidth information to final users over ordinary copper telephone lines. When we use DSL, the information is transmitted as digital data, so it is possible to use a higher bandwidth for the transmission. It is possible to transmit simultaneously data and voice signals because a part of the bandwidth is destined to transmit the analog signal (voice) while the rest of the bandwidth is employed for digital transmission (data).

If the final user is close enough to a telephone company central office that offers DSL services, it is possible to receive data at bit rates up to 6.1 Mbps (theoretically, 8.448 Mbps). However, as this is not the general case, guarantee rates oscillate between 1.544 Mbps to 512 Kbps downstream (from the server to the user) and about 128 Kbps upstream

(from the user to the server). ADSL line can carry both data and voice signals, and the data part is continuously connected. DSL installations began in 1998, and given the bandwidth they provide, they are suitable for the transmission of live video, audio or 3D.

Another way of obtaining a high bandwidth for the Internet connection is using a different cable for the connection. Cable TV companies use coaxial cables to communicate between the community antenna and user homes or enterprises. Using a cable modem, final users can connect their PC to a cable TV line and receive data with a bit-rate of about 1.5 Mbps. This rate is about the one available to users of DSL services, and is much better that the 56 Kbps that can be achieved with telephone modems and 128 Kbps of ISDN.

The cable modem has one connection to the coaxial cable wall outlet, and the other to a PC or a set- top box for the TV set. It can be integrated within the computer or the set-top box (for television), but it can also be an external device. If it is an external device, it can usually be connected to the Ethernet card in the computer. The cable modem communicates with a CMTS (Cable Modem Termination System) at the cable TV office. It is not possible for the cable modem to receive and send signals to other cable modems on the network, only to the CMTS.

2. Applications for Internet and intranets

Since the creation of ARPANet at the end of the 60s, many network services have appeared and most of them are widely used at present times. In this point, we are going to comment some of them that can have applicability in the psychological field, especially as tools that can help to provide remote psychological care.

2.1 File transfer protocol (FTP)

The goal of this service is to be able to have access to a file system of a remote computer to check its directory, to transfer a file to the remote computer to ours, or vice versa.

As we cannot access remotely to the Operating System (OS) of a machine, a process acts as an intermediary between the file system of the remote machine and the local machine. The Virtual File System (VFS) offers to the client machine some commands that allow listing the directory, copying a file, deleting a file, writing a file, etc.

2.2 E-mail

This is a file transfer in which the file has a pre-defined structure with some fields that remind the ones from an ordinary letter. E-mail is now widely used for intracompany and intercompany communication. It allows people located at distant places to cooperate on complex projects

It is an asynchronous application, as long as the user creates the e-mail, specifies the addressee and sends it. There is no guarantee that the addressee will read the e-mail (or even respond to it) immediately.

E-mail systems usually consist of two subsystems [6]: the user agent, which allows people to read and send e-mail, and the message transfer agent, which moves the messages from the source to the destination.

User agents are programs (usually called mail readers) that accept a variety of commands for composing, receiving and replying to messages, as well as for manipulating mailboxes.

On the other hand, message transfer agents are usually system daemons that run in the background and move e-mail through the system.

2.3 World Wide Web

This service allows the access and transfer of known documents as web pages, with an independent address system, from a server which is connected to internet, using a client application which is called browser.

The first web application was built in 1989 in the Cern lab (Switzerland) [7]. In 1993, the first commercial browser appeared: MOSAIC [8]. In 1995, the first version of Netscape was distributed [9]. It was followed by the web browser from Microsoft: Internet Explorer[10].

2.3.1 HTTP Introduction

The HTTP (HyperText Transfer Protocol) is the protocol that is used for transferring pages.

The client application is the web browser, and the web server that is used depends on the operating system of the server machine. For example, for UNIX, the most habitual selection is Apache [11], and for Windows NT or 2000, Internet Information Services (IIS) [12] is commonly used.

The way of indicating the page that we want to visualize in our browser is by means of an URL (Uniform Resources Locator). The URL is composed of three components:

- The transfer protocol.
- The domain name. A domain name is a meaningful and easy-to-remember way to refer to an Internet address. This part of the URL indicates a domain name server using the domain name system (DNS) where to forward a request for the web page. The domain name is mapped to an IP address.
- The path.

An example that shows the different parts of the URL is the following:

TRANSFER PROTOCOL	DOMAIN NAME	PATH
http://	www.upv.es	/dir1/dir2/document.html

2.3.2 Markup languages

A markup language is a language for annotating some text with additional information, such as how the text should be displayed. SGML (Standard Generalised Markup Language) [13] provides a standard metalanguage on which a great variety of markup languages is based. In SGML text is marked with start and end tags to label particular elements in the text. For example, we can write:

<user>Name Surname</user>

as a way to introduce the name of one of the users of our system.

SGML defines the way to use this kind of elements (with the initial and final tags), but it does not specify what kind of elements can be used in the format, and in what way they can be nested.

Any language based on SGML should provide a definition of the set of elements that can be used and which ways of nesting are appropriate for a particular application.

HTML (HyperText Markup Language) [14, 15] is a markup language designed to achieve the needs of documents that are prepared for the World Wide Web, which is an application with its own requirements. For example, HTML includes instructions that define how the document will be displayed. And inside an HTML page some references to

other HTML pages can be included (what is called a hyperlink). The browsers are prepared to interpret the information that is codified by means of the tags.

HTML was invented in 1989 by Tim Berners Lee. Initially, it had only a reduced set of tags, but with the use, new purposes were thought, so new tags appeared and were added to the original set. Several versions of HTML appeared: version 2.0, 3.2, 4.0 and 4.1.

HTML 4.1 is now widely supported. All these standards are co-ordinated by the World Wide Web Consortium (W3C). Since HTML 3.2, it was suggested that the best way to define presentation parameters is by means of a stylesheet. This is a set of instructions that specify how the different elements of the HTML document should be displayed: the colour for the different levels of a hierarchical structure, the font, etc.

Cascading Style Sheets (CSS) can be used in an internal or an external way. In the internal way, they are included inside the structure of an HTML file. In the external way, they constitute an independent document (with .css extension) that can be applied to a whole set of web pages.

Using HTML, we may want to use some specialised tags. For example, a session of a therapy can be indicated by a "session" tag. However, it does not exist in HTML. That is one of the reasons that motivated the creation of XML (eXtended Markup Language) [16, 17], a new metalanguage that allows the creation of specialised tags that describe the structure of the document in a more meaningful way.

The idea is to structure the information based on the meaning of each single element. XML does not describe how the information will be presented to the final user.

However, since Internet Explorer 5.0 it is possible to visualize XML documents as a tree structure with different colours depending on the level. This is only a way between multiple alternatives to visualize the structure that is contained in the document. If we want to configure the way of displaying an XML document, we can use a CSS as it can be used in HTML, but it is better to do it using the XSL (eXtensible Stylesheet Language). XSL permits to transform (even altering the order, structures and contents as required) and format XML documents.

2.3.3 CGI, ASP, JSP, PHP

Up to the moment, we have talked about web pages that only structure information and present it to the user. However, this is not the general case.

When HTML was created, web pages were located in a remote server, and the client computer downloaded them. This was the only communication direction: from server to client. However, at the beginning of the 90s it was thought the possibility of sending data also in the other direction, from the client to the server. From HTML 2.0, a tag was defined that allowed the user to include data in an HTML page and send them to the server (with the command POST that is defined in the http protocol). The html form element defines an area in the web page where the user may enter information. Different input elements can be introduced in that area and they permit that the user enters the data in different ways: radio buttons, check boxes, buttons, etc.

But it is not only interesting to send these data, but also to analyze them or do some processing with them. Programs that use these data are called CGI (Command Gateway Interface). A CGI program is physically located and executed in the server and takes as input data the ones that are introduced using the FORM tag.

Programmers can write CGI applications in different languages. The most common are C, C++, Java and PERL (Practical Extraction and Reporting Language) [18].

However, there are alternatives to the use of CGI to process the data. We are going to comment some of them: ASP, JSP and PHP.

An Active Server Page (ASP) [3, 19] is an HTML page that includes one or more scripts that are processed on a Microsoft Web server before the page is sent to the user. Usually, the script uses as input the data received as the result of the user's request for the page and then modifies the appearance of the page before sending it to the client. ASP is part of Microsoft Internet Information Server, but it can be delivered to almost any browser.

Scripts can be written in VBScript or JScript. The file is named with the ".asp" file suffix.

JSP (Java Server Page) [3, 20] is a technology for controlling the appearance of web pages using small programs that are included in the web page (servlets) and run on the web server. It is comparable to Microsoft's ASP, but it was developed by Sun Microsystems. In this case, JSP calls a Java program that is executed by the web server.

Finally, PHP (Personal Home Page Tools) [3, 21] is a script language and interpreter that is freely available and used mainly on Linux Web Servers. It is a cross-platform alternative to ASP technology. The PHP script is embedded in an HTML web page. It usually has the file name suffixes ".php", ".php3" or ".phtml". Before the page is sent to a user that has requested it, the web server interprets and performs the operations described in the PHP script.

All these pages can be defined as dynamic html pages, since content varies depending on the results of executing the scripts or programs.

2.3.4 JAVA

All the programs and scripts that we have discussed in the previous point are executed in the server. However, it was thought that a useful alternative would be to distribute the processing tasks, giving the client the possibility of executing programs. That is the reason why Java language [22] was developed.

Java can generate an intermediate code that is interpreted by the browser, so programs can be executed independently from the platform.

The server compiles the program that is written in Java, and generates the intermediate code called bytecode, which is not executable. This program is introduced in HTML pages. The browser is capable of interpreting both the HTML content and the applets. The applets will be executed in the client interpreted by the web browser when the user references them by means of their URL.

Also, the scripts that are imbedded in web pages (such as Java Script or Visual Basic Script) can be interpreted by the browser (at the client side). It is another possibility for de-centralising the processing tasks from the server.

2.4 Information exchange applications

The previous applications that we have described did not imply a direct and synchronous communication between people. Only the e-mail guaranteed a communication between at least two people, but it was in an asynchronous way.

In this point, we are going to comment other technologies that enable us to communicate directly with other people. Applications can be text-based, so the communication will be by means of texts that will be introduced in the computer by means of the keyboard and sent through the network to a remote computer. We will comment two of these applications: chats and instant messaging.

Applications can also be based on images, so it will not only be possible to send the text that a person has introduced, but also his/her image or voice. We will comment the videoconference application.

2.4.1 Chat

A chat room is a web site, part of a web site, or part of an online service that allows communities of users with common interests to communicate in real time. Most chats do not require that users have any special software, and if they do, such as the IRC (Internet Relay Chat), it is possible to download it from the Internet [23].

When a user wants to enter in a chat room, he/she chooses a user name and a password, and logs into the room of his/her interest. Normally, there is more people online and a signal makes them know that another person just entered in the room. As this is a text-based application, users type the message they want to communicate to the group into a text box, and this message appears in the common area where messages from other users also appear. Then other users can respond to this message. The user is not forced to send messages, so he/she can remain reading messages from other users.

2.4.2 Instant Messaging

Instant messaging (IM) application [3] allow users to know if some chosen people (friends, family, co-workers) are connected to the Internet, and, if they are, to exchange messages with them.

The main difference with the e-mail is that in this case it is a synchronous application: when one user sends a message to another it arrives immediately to the other side, and it is possible to obtain an instantaneous response. The only condition to do instant messaging is that both users should be connected to Internet at the same time. The IM application has a list with the user's selected contacts, and indicates at any moment if they are connected to the Internet, or even their state (for example, the application determines if the user has been away from the computer during a while).

When a message arrives to a user from a different user, a window appears indicating that an IM has arrived, so the user can accept or reject it, or a window appears containing the message. This depends on the concrete application that we are using.

The most commonly used applications for Instant Messaging are AOL Instant Messenger [24], MSN Messenger [25], Yahoo! Messenger [26], ICQ [27], etc. Most of the information that is transmitted using this kind of applications is text-based. However, new versions of different applications allow voice messaging, file sharing, etc.

Moreover, instant messaging systems are beginning to deliver messages to devices different from PCs, such as mobile phones, PDAs (Personal Digital Assistants), etc.

In words from Bill Gates, one "of the most powerful and distinguishing features of the IM protocol is 'presence detection', -i.e., the ability to allow users, subject to their control, to let others know when they are 'online' and available and which Internet-connected devices they are using (...) IM can bring additional capabilities to wireless tools, such as telephones and PDA devices; and, IM can play an important role in interactive TV offerings" [28]

2.4.3 Videoconference

A videoconference is also a live connection between people in distant locations with communication purposes. In this case, it implies the transference of audio, text and video.

In its simplest version, it only transmits static images and text, being similar then to an instant messaging application. However, sophisticated versions allow the transmission of video images and audio.

The possibility of visualizing the face of the person at the other part of the connection adds non-verbal features to the communication, which can contribute to a stronger sense of familiarity.

Regarding the requirements that are needed for a videoconference, the software is usually free or not very expensive. For example, Microsoft's NetMeeting [29] is included in Windows 2000 and can also be downloaded for free from the NetMeeting homepage.

Regarding hardware, a common PC with Internet connection and a digital camera are enough to allow the user to have a cheap connection with distant family, friends or co-workers, although this quality can be improved with more elaborated configurations.

2.5 Multimedia services

A multimedia application works with different information sources, such as alphanumeric data, fixed images, animated images, voice, video... The main characteristic of these applications, that distinguishes them from other kinds of applications, is that most of the data come from continuous data sources such as voice and video. For example, the videoconference that we have described in the previous point about information exchange applications can also be classified as a multimedia service, as long as we have continuous data sources of video and audio. In this case, they are captured and digitalized and then transferred through the network. In other cases, the original data are already digital.

The other characteristic of these applications is that, as data sources are continuous, they generate a high volume of information, so they require a high bandwidth in the network, with connections such as cable or DSL. And the latency (that is, the time that it takes to transmit a single unit of information from one side to the other) should be delimited.

Besides, special hardware devices or interfaces are required, such as cameras, video and audio digitalizer boards) that generate digital data from analogical inputs.

We can distinguish between two types of multimedia applications:

- Direct applications. They are affected by latency. In real time, digitalization and transmission are made at one side, and reproduction at the other side. An example is videoconference.
- Applications with a previous storage. After digitalizating the information, it is stored in a server, and is recovered in an asynchronous way by the clients. An example of this kind of application is video on demand.

In order to reduce the problem of the high volume of information, techniques of compression are used. There are different kinds of algorithms, with and without losses.

Normally, for Internet application algorithms with losses are used. The most commonly used algorithm to compress data is MPEG [30], used both video and audio.

There are different versions of MPEG.

2.5.1 Quality of service

With the concept of Quality of Service (QoS) we intend to guarantee in advance a minimum transmission rate, error rate and other characteristics that are indicators of the quality of the transmission. It is usually applied to Internet connection, but it is especially interesting for the continuous transmission of high-bandwidth video and multimedia information.

In the strictest sense of the word, quality of service can be defined as the ability to offer guaranteed bandwidth while maintaining specific link quality, delay and jitter

parameters for satisfactory delivery of isochronous applications [31]. These requirements are based on human perceptual studies for voice, video, audio and interactivity.

The most important parameters that are used to define QoS are the following [31]:

- Bit rate. It is measured in bits per second. Depending on the quality of video, bit rates from 300 Kbps (streaming video) to 20Mbps (HDTV) are needed. Technologies chosen for multimedia applications need to provide enough bandwidth to maintain multiple high quality links demanded by users.
- Link quality. It defines to what extend the communication takes place "error free". The parameter that is usually given is bit-error-rate, which indicates the percentage of bits with error that arrive to the final user. It is not enough to have a high bandwidth, because without low bit-error-rate the transmission will not be correct.
- Delay or latency. It is the time difference between the transmission and reception of packets of information from source to destination. This factor is critical for interactive applications, such as videoconference. A delay of less than 100 ms is required.
- Jitter. It is a variation in arrival of data packets. Jitter can be minimized at the receiver using buffers to control the delay variation. This is usually employed in applications such as streaming video. A typical maximum value for jitter for high quality video is about 10 ms.

Depending on the final application, the restrictions for these parameters will be different.

An application can be restrictive only with one of the parameters, and not so much with the rest of them.

2.5.2 Video on demand systems

In video on demand systems [6], the user selects one from a large number of available videos from a remote server using the television set's remote control, and the video starts immediately. As people are used to the possibility to stop, start, rewind and forward videos, a complete video on demand system should provide the user with these controls. That means that the video provider will transmit a separate copy of the film for each different user.

There are simpler schemes called near video on demand. They offer the advantage of their lower cost. In this case, it is sufficient that each popular film starts every 10 minutes, and run them non-stop. Although the user does not have the possibility of controlling the reproduction (play, stop, rewind...), he/she always has the possibility of changing to another retransmission of the film.

The main parts of a video on demand system are: the video servers, the distribution network, and the set-top boxes. The video servers should be capable of storing and transmitting a large number of movies simultaneously. There are different alternatives for the distribution network, but in any case, it is required a wideband networking. Finally, set-top boxes are the final point where movies arrive. They have to decode and allow the visualization of the movies; in fact, they are powerful, specialized personal computers.

2.5.3 Development tools

Depending on the multimedia system that we plan to design, we can use different tools. For example, for a video on demand system we will need to configure a video server that is able to store and output a large number of movies simultaneously. That configuration includes both the hardware and the software part. Several applications for providing streaming video are available. Between others, we can mention: Helix Universal Server

from RealNetworks [32], Windows Media Services from Microsoft [33] and QuickTime Streaming Server from Apple [34]. The advantages of these server software packages are that they add some functionality related to load balancing, automatic bandwidth negotiation and the ability of users to fast-forward through the videos in the server.

However, videoconference and video on demand systems are not the only alternatives if want to add multimedia content to the Internet. We can use some authoring tools such as Macromedia Flash [35] to include interactive streaming video, animations, audio, vector and bitmap graphics into web pages. That is a way to create very impacting user interfaces for different kind of final applications.

2.5.4 Sample applications

Several sample applications can be thought with these kinds of multimedia tools. Besides the ones that we have previously described (videoconference and video on demand), many other multimedia applications are being used in web pages for different final applications.

Of particular interest are dynamic presentations for enterprises, games for entertainment purposes, educational programs for children, etc. In the following points we will describe how this kind of tools can be useful for the psychological field.

3. Data storage and standardization

Technology can help us to provide remote psychological assistance to users. In the previous point we have described the technologies that support that kind of applications.

One of the possibilities that web technologies offer us is to collect data from the user (using forms in html pages). This data can be processed at the server, but usually we will be interested in storing it so the psychologist can consult it later in case it is needed. That is why we will need some kind of technology that supports that data storage: databases.

But we do not need only to store that data; it will be interesting to store that data in a standard way. There is still not a standardised way to store psychological data, but some approaches have been made, and we will comment one of them later [5]: the use of XML as a possible way to structure and organize data about the evolution of users of a telepsychology application.

3.1 Introduction to databases

A database is a collection of data that is organized so that its contents can easily be accessed, managed and updated [3].

In relational databases data is stored in a tabular structure so that it can be organized and accessed in different ways depending on the purposes. Relational databases were invented by E.F. Codd at IBM in 1970 [36].

The structure of a relational database is a set of tables that contain data classified into different categories that are structured in columns. For example, if we are collecting data about the responses of a user inside a psychological application, we can have different columns for data such as user identification, age, sex, responses to questions about anxiety, responses to psychological questionnaires, etc.

There exists a standard interface to access to the data stored in relational databases.

It is the structured query language (SQL) [37]. Depending on the information in which we are interested, we can extract it from the database using the appropriate database commands. SQL is a language for making interactive queries from and updating a database

such as IBM's DB2, Microsoft's Access, and database products from Oracle, Sybase, and Computer Associates.

The main advantages of relational databases are that they are relatively easy to create and modify.

Once a database structure has been created, it is easy to add new data categories, without modifying applications that work with previous data categories.

3.2 XML

We have described previously the XML format as a way to structure information that can be visualized in browsers using style sheets (XSL). However, we can also use XML as a way to organize data collected from the user, without worrying about the presentation. This can be especially interesting for medical and psychological applications.

This technology allows modelling the patient status, the actions carried out during the treatment and all complementary data that is needed in a patient file. This file can be transmitted from the patient's computer to the control system (a remote server), so it is possible to use it as a way to de-centralise and standardise the data for communication between the different elements composing the system. Data can be processed locally without requiring a centralised server that provides all the system intelligence, and be sent to the control system at the end of the session.

Data stored in XML can easily be adapted to other formats, so that compatibility with other systems is provided. And it allows for remote data access, for example to the clinic story of a patient.

Besides, XML allows the inclusion of "metadata", for example, the description of the structure and format of the data goes along with the data itself, and it includes mechanisms for validating the structure of the data records.

All these characteristics suit perfectly the transmission of highly structured medical/psychological information through Internet / intranet.

4. Virtual environments in web pages

A tool that has been commonly used in recent years for phobia treatment is 3D virtual environments. Besides, the development of 3D interactive graphics has become one of the major sources of impulse for the IT sector in the latest years. Spectacular advances have been achieved by the parallel evolution of hardware (by means of graphic accelerators) and software (with the evolution of OpenGL or DirectX).

For psychological treatment purposes, virtual reality can be seen as an intermediate step between the therapist's consulting room (a totally protected environment) and the real world [5]. A good approach to provide remote psychological treatment is based in the use of virtual environments inside web pages. In this point, we are going to describe some technical alternatives.

4.1 Requirements

If we plan to use a virtual environment imbedded in a web page, several technical configurations should be taken into account. When we design a virtual environment, we can give importance to the realism, which in technical language implies the use of more complex geometries for the modelling of the environment, more realistic textures, radiosity algorithms, etc These factors make that the size of the virtual environment file grows. This

is acceptable as long as we are going to run the environment in a local machine. If we plan to run the virtual environment from a web page, two alternatives can be taken:

- Design the virtual environment in a way to reduce the size of the final file. That will imply a reduction on the realism of the environment, which can be acceptable depending on the final application.
- Send the virtual environment to the user in a CD (or allow the user to download it from the internet before using it and copy it in the local hard disk of his/her computer). That way, the user will have a local copy of the virtual environment, and the web page can access to it when it is required. One requirement in this case can be to guarantee that the environment is only run from the web page. In order to do that, several strategies can be thought that depend on the technology that we have used to develop the virtual environment. For example, if the technology allows that parameters are passed from the web page to the virtual environment, some initialization password can be sent to the environment at the beginning of the session. If the user runs the environment locally, this password will not be sent, so the virtual environment will not work.

4.2 Development tools

Currently, two approaches coexist in the use of 3D graphics inside the web browser:

- A proprietary software. For example, we can mention the Virtools software [38]. This software must be installed as a plug-in (automatically or specifically).
- VRML (Virtual Reality Modelling Language) [39]. It is a file format and run-time description for 3D graphic elements for use on the World Wide Web. It includes interaction and animation elements as well as interfaces to scripting languages to provide more general simulation behaviours to network services. Currently, VRML worlds can be scripted with Java and JavaScript, both of which are familiar to most web programmers.

5. Telepsychology applications design

The adaptation to Internet of psychopathology involves the application of a range of available technologies. In the previous points we have described several services that are available for the Internet.

FTP provides a way for transferring files between the therapist and the patient: documentation that the patient should read, writings of the patient that are important for the therapist in order to make a diagnosis or treatment, virtual environments that the user has to install in his/her computer to follow the treatment, etc.

Other tools such as e-mail, chats, instant messaging or even videoconference provide ways of establishing a direct communication between the therapist and the patient, which allows the user to ask for the therapist's help when it is required, or even to have online sessions in which both the therapist and the user take part.

Of course, the World Wide Web offers a much wider field of actuation. Web pages can be designed that control a structured treatment that the patient should follow, and store the answers and evolution of the patient in a database, perhaps in an standardised format that can be shared between different applications, such as XML.

Virtual environments can also be integrated in web pages and be used as a part of the treatment. Or a video server can be prepared with different videos that the therapist considers useful for the therapy, and the patient can download them following the

psychologist's instructions, or navigating from a web page that controls which is the order in which videos should be visualized.

Telepsychology is a wide field. A quite frequent strategy is to provide information on particular disorders and the existing therapeutic possibilities. An example of it can be found in the TAPIR ("The Anxiety Panic Internet Resource") frame [40]. But in recent years, other approaches have appeared, such as self-help remote applications that follow a structured treatment protocol so it is possible to ensure that the user does not skip any step in the treatment, gaining more control of the process such as Talk to me, a system for public speaking fear treatment on the Internet [5]. In the following points, we pretend to describe the points that should be taken into account when designing a remote psychological treatment application.

5.1 Psychological considerations

The first step to design a remote psychological treatment application will be to describe in an exhaustive way its goals and in the kind of treatment that is required.

Between other aspects, it should be clarified which kind of treatment it will be: a full self-help treatment or a therapist-guided treatment. It has to be selected the kind of psychological disorder that it should address and the psychological protocol that should be followed.

5.2 User requirements analysis

Taking into account that we are designing an Internet application, we cannot presuppose that the patient has any special hardware or software at his/her home.

For most applications, the only hardware requirements for the user will be to have an Internet connection and a standard PC, with a graphics card in the case we plan to use virtual environments for the treatment.

Regarding software, it is possible that the user has to download some software before starting the treatment. It has to be clarified during the design phase and clearly specified in the final application so a normal user can easily install everything that is needed for a correct operation of the application.

In some concrete applications, it is possible that the user has to use some specialized hardware or software. These will probably be applications for specific users, and they will have to provide some kind of technical assistance to help the user to configure the system.

5.3 Tasks analysis

During the evolution of the treatment, several stimuli will be presented to the user. In the design phase, it has to be selected which kind of stimuli: images, texts, animations, virtual environments, etc. And once it has been done, the most appropriate alternative from the technical point of view has to be chosen. For example, images can be presented integrated in web pages, and the user can access to them following a predefined order that the navigation through html pages forces. The same can happen with the text. Animations and virtual environments have to be developed using some of the development tools that have been analyzed in previous points. And after that, they can also be integrated in web pages.

Depending on the estimated size of the virtual environment files, the user can download them before starting the treatment or they can be used directly from the web.

A second point that has to be considered is the control of the patient activity. The normal case is that the patient should follow a controlled flow decided and supervised by the system. To assess the evolution of the patient, different tools such as questionnaires can

be used. User responses can be analyzed by the system to determine if he/she can continue with the treatment. During the design phase, it has to be decided if these responses should be stored by the system, so the psychologist can consult them afterwards. If it is the case, it has to be designed a database system to store the data, and select the format in which it has to be stored.

Finally, another point is the connection between the patient and the psychologist. It has to be decided which kind of tools will be used, ranging from e-mail to videoconference.

5.4 User interface design

Although this is the last point we are describing, this is not the least important. The design of the psychological and technical aspects that support the application are the basis, but it is decisive that the application is attractive from an aesthetic point of view. Web page designers have experience in this kind of tasks and will make that the final application has a good appearance.

6. Future trends: wireless devices

With this chapter, we expect to have given a general overview of the techniques that can be used for the design of telepsychology applications. However, we do not want to finalize it without describing a new set of technologies that can be the basis of many future psychological treatments: wireless devices.

6.1 Wireless devices characteristics

Wireless devices include a variety of different hardware terminals such as PDAs (Personal Digital Assistants), cellular phones, etc. Divisions between cellular phones and palm-top computers are expected to become increasily indistinct [41] and many products appear in market that combines the functionality of both types of devices.

Some common characteristics of these devices are the following:

- They have a reduced size and can usually be held inside the hand. That is why they also receive the name of handheld devices.
- They have a reduced computing power when compared with a PC.
- The display has small dimensions, so the content has to be adapted to the characteristics of the screen before being displayed.
- The way to introduce text is different that the one used in PCs. It can be a virtual keyboard that appears in the screen, the device can do writing recognition or it can be included a small keyboard in the terminal.

6.2 Internet applications

There are versions of browsers that have been designed specifically for handheld devices.

Contents of web pages have to be adapted in the server to the characteristics of these devices, especially display size.

Regarding the way to connect to Internet from these terminals, it has to be a wireless connection, because the use of cables will impede that they are used any time at any place. Many alternatives are available currently.

The GSM network completed with the WAP protocol is one of them, although it has the inconvenient that it is circuit-switched [3], with a single connection between two end-

points in the network for the duration of the connection, so the billing method is based on this duration.

GPRS is gradually spreading and it provides packetized data transmission at bit rates of 100 Kbps and over [41].

In the near future, the implantation of third generation of mobile systems (UMTS – Universal Mobile Telecommunication System) [3], also packet-based, will offer a bandwidth of 2 Mbps, so more applications can be easily integrated in wireless devices.

On the other hand, Wi-Fi technology (802.11b) [3] is also rapidly growing and it can be an alternative to wired LANs. It allows bit rates up to 11 Mbps, so if the terminal allows Wi-Fi connectivity, this can be an appropriate alternative for having an Internet connection in places where a wireless LAN is available.

6.3 Multimedia

Bandwidth is the most important limitation that we have at present to develop multimedia applications for wireless devices.

However, software applications have been developed for wireless devices that allow the visualization of video-streaming in PDAs or cellular phones, such as Windows Media Player for Pocket PCs [42].

Versions of Flash MX for handheld devices have also been developed [43]. They allow the visualization of interactive content and animations.

6.4 3D environments

Regarding the possibility of using 3D environments in wireless devices, the main limitation is in their graphics processors. Their capability for 3D hardware acceleration is reduced or null.

However, we expect that in the near future more powerful graphic processors will be integrated. And meanwhile, several software alternatives for visualizing 3D content are available.

There are VRML browsers for wireless devices (such as Pocket Cortona from Parallel Graphics [44]).

Other alternatives include the Swerve3D viewer that has been developed by Superscape [45]. The interactive content is independent from the hardware and only requires that the Java Virtual Machine is present in the device.

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10 Technological Background of VR

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Abstract. User interface (UI) design is a critical component of any virtual environment (VE) application, and especially for VE applied to medicine. User interfaces for VE are becoming more diverse. Mice, keyboards, windows, menus, and icons - the standard parts of traditional WIMP interfaces- are still prevalent, but nontraditional devices and interface components are proliferating rapidly. These include spatial input devices such as trackers, 3-D pointing devices, and whole-hand devices allowing gestural input. Three-dimensional, multisensory output technologies -such as stereoscopic projection displays, head-mounted displays (HMDs), spatial audio systems, and haptic devices- are also becoming more common. In this chapter we present a brief overview of 3-D interaction and user interfaces technologies for VE.

1. Introduction

User interfaces (UIs) for computer applications are becoming more diverse. Mice, keyboards, windows, menus, and icons - the standard parts of traditional WIMP interfaces- are still prevalent, but nontraditional devices and interface components are proliferating rapidly. These include spatial input devices such as trackers, 3-D pointing devices, and whole-hand devices allowing gestural input. Three-dimensional, multisensory output technologies -such as stereoscopic projection displays, head-mounted displays (HMDs), spatial audio systems, and haptic devices- are also becoming more common.

With this new technology, new problems have also been revealed. People often find it inherently difficult to understand 3-D spaces and to perform actions in free space.

Although we live and act in a 3-D world, the physical world contains many more cues for understanding and constraints and affordances for action that cannot currently be represented accurately in a computer simulation. Therefore, great care must go into the design of user interfaces and interaction techniques for 3-D applications, especially for Medicine. It is clear that simply adapting traditional WIMP interaction styles to three dimensions does not provide a complete solution to this problem. Rather, novel 3-D user interfaces, based on real-world interaction or some other metaphor, must be developed.

This chapter is a brief overview of the current state of the art in 3-D user interfaces and interaction available today.

2. The Virtual Experience: INPUT Interface

In a Virtual Reality (VR) System is very important that the user can "live" the Virtual Reality Experience of the most realistic possible way. But, how the user can to *participate* (*communicate*) with a virtual experience? What *technological methods* can to use this user in order to manipulate and travel through the virtual experience?

Before continuing is important to make this explanation. Basically there are two ways of input to a VR experience: *User Monitoring* (the real-time monitoring of the user's actions) and *World Monitoring* (the real-time monitoring of the real world). Now, we will centre us in the first way because, possibly, it is the most interesting since it affect directly to the user and how he/she can to make anything in this VR experience.

The *User Monitoring* provide to the user a way in order to tell the virtual world what he/she want and track at least some part of their body. We will make a brief introduction to several ways of monitoring a user's interaction with a virtual world, that is, *Tracker Systems* and other *Physical Input Devices (Physical Controls)*.

2.1 Tracker Systems

In a VR experience it is very important to know (to track) continuously the user's movements in the virtual world because this is what allows the VR system to render and display the virtual world from a user-centric perspective and, in this way, providing the effect of physical immersion.

This is possible thanks to the *Position Sensors*, that is, devices that provide its location and/or orientation to the computer. These devices are used in order to communicate the VR system where is located the user within a virtual reality world; the user head, the user hand and even both things.

There are several types of *Position Sensors*:

- *Electromagnetic*
- *Mechanical*
- *Optical*
- *Ultrasonic*
- *Inertial*

- Electromagnetic:

This type of position sensors uses a *Transmitter* (it is fixed at a know location and orientation) in order to generate a low-level magnetic field from three orthogonal coils within the unit. Each one these fields will generate current in another set of coils that it will be in a smaller *Receiver* unit (it is fixed on the user head, hand or in any other device manipulated by him). Thanks to the measures of the signal in each coil of receiver is possible to know its position and orientation relative to transmitter, that is, where the receiver is and how is oriented.

Limitations:

- Interferences because of metals in the environment
- Short range (3-8 feet) of the magnetic field generated

Advantages:

- No line of sight restriction (no problems with visual or sonic obstacles between transmitter and receiver)

- *Mechanical:*

In this type of position sensors the track may be carried out through mechanical systems. For example, the BOOM systems, mechanical articulated armlike with visual device in one of their ends. In these systems, the user can strap this visual device in their head or put their face in it and grasp it with some handles. The BOOM will follow the head user movements within a limited range and, thanks to each elbow joint and connecting link, it will can to measure and calculate the head user position and orientation. Moreover, it is possible to incorporate motors to the BOOM linkages. In this way, it will possible to simulate force (pressure and resistance) effects.

Limitations:

- User location restrictions

Advantages:

- Very fast and accurate system

- *Optical:*

This type of position sensors uses visual information in order to track the user or the objects. It is possible tanks to a video camera (it is in a fixed location) that acts as an electronic eye that it is "watching" the tracked user or object. Normally, this user or object will have placed a sensor device (light-sensing devices) that it will be watched. Using complex computer vision techniques and being based on what the camera sees, it will be possible to calculate the user or object position.

If the user or object have a single sensor device, their position will can be reported in only two dimensions but without depth information. Nevertheless, this problem can to solve if the user or object have multiple sensors. In this way, the system will can triangulate the location and/or orientation of the tracked entity, providing three-dimensional position information. Moreover, if the system use three visual input devices (three video cameras) in different locations, it will be possible to calculate a full 6 DOF (Degrees of Freedom –a particular way in which a entity may move in space) position.

Limitations:

- Line of sight restriction (problems if obstacles between the tracked person or object and the camera)
- Therefore, limitation in the participant´s range of movement

- *Ultrasonic:*

This type of position sensors uses high-pitch sounds emitted at timed intervals in order to calculate the distance between the transmitter (speaker) and the receiver (microphone) and, in this way, to track the user or the objects. In order to obtain the full 6 DOF position of a user or object is enough the use of three transmitters combined with three receivers.

Limitations:

- Interferences when operated in a noisy environment
- Short range of action
- Encumbrance (wires attached to the transmitter and receiver)

Advantages:

- Fairly inexpensive way of position tracking

- *Inertial:*

This type of position sensors uses electromechanical instruments (accelerometers, inclinometers) in order to detect the relative motion of sensors by measuring change in gyroscopic forces, acceleration and inclination [1].

An inertial device is a small sensor that is attached to the object being and connected to the computer via connecting wire (often there is an intermediate device or "black box" that it will convert the signals to appropriate levels and digital communication protocols) or with wireless transmission technology (radio). An inertial device has the same technique of operation by which the inner ear aids in knowing the head orientation, that is, a fluid tends to remain motionless while the surrounding structure rotates. In this way, inertial sensors relay information about the location of the structure relative to fluid.

Limitations:

- Not provide location information
- Limited to orientation-only measurement

Advantages:

- No range limitation
- User freedom movements
- Quality inexpensive
- Easy incorporation and use with HMDs
- Can be combined with other tracking systems in order to provide the best method

Any of these technologies are better that the other. All these types of *Position Sensors* have their advantages and disadvantages, their benefits and limitations (normally, these limitations arise from technology used to determine the relationship from some fixed origin and the sensor) . Besides cost, these are the questions to keep in mind:

- *Accuracy / Precision* and *Speed* of the reported sensor position
- *Interfering Media,* that is, metals, opaque objects, etc.
- *Encumbrance*, that is, wires, mechanical linkages, etc.

Therefore, when a designer and developer of VR systems are planning a VR experience, will must keep in mind all this and choose the most appropriate system. A possibility is to consider the ability of the system chosen in order to produce an acceptable experience, that is, an experience without noise, low accuracy and lag time, factor that decrease the realism and immersion of the virtual experience and that they can lead to nausea in the users.

2.2 Physical Controls

Physical Controls are another part of the interface between the user and the virtual world, that is, individual *buttons* (two positions: depressed or released), *switches* (two or more positions), and *valuators* (a range of continuous values - sliders and dials) that allow users to actively provide input directly into the virtual world. Several of these devices can be combined into a single input device that it will can be designed as generic devices (usable in multiple applications) or as specific device (usable in specific use). Also, they can be mounted on a handheld *prop* tracked by the VR system, on a *platform* used in a virtual reality experience, etc.

Now, we will make a brief introduction to the two new terms mentioned previously:

- *Props*
- *Platforms*

- *Props:*

These devices are physically objects used as an interface to a virtual world.

Normally, these objects are built for a specific purpose in an application and represent some object in a virtual world, that is, they may be embodied by a virtual object. These devices might have physical controllers (buttons, switches and/or valuators) mounted on it and, also, some tracker system. The props have physical properties (shape, weight, texture, centre of gravity and solidity) that provide some haptic information to the user and they suggest him its use in a virtual reality experience. There are several types. The most common are wands and 3D mouse (they can move in two directions and also they can report height information).

When a user manipulates a real object that it is simulated in the virtual world, he/she think that the virtual experience is more real and, also, the rest of the virtual world seem more real too. These feature, well-known like *transference of object permanence*, and the other features mentioned previously, convert this input interface in a natural and intuitive devices in order to interact with the virtual experience.

- *Platforms:*

These devices are physical structures in which the user is situated. Normally, they simulate a real world device found in the virtual world, but sometimes they are simply a place to sit or stand. Also, it is possible the user interact with the virtual world manipulating real world objects included in this platform. Moreover it is possible to incorporate motion systems (hydraulic or electric systems) in the base of these platforms (*motion platforms*) providing, in this way, a very natural interface with the virtual experience. There are several types. The most common are *ring*, *kiosk*, *ambulatory* and *vehicle* platforms. In any of them are limited the visual device that could use. There are examples in both HMDs and screen/projection devices.

3. The Virtual Experience: OUTPUT Interface

In a Virtual Reality (VR) System is very important that the user can "live" the Virtual Reality Experience of the most realistic possible way. But, how the user can to *perceive* a virtual experience? What *technological methods* can to use a virtual reality system in order to present information to any of the users' senses?

Before continuing is important to make this explanation. The human perceptual system has five senses providing information to the brain but, only, we will study three of these senses (visual, aural and haptic) because the other two senses is not sufficiently developed from a technological point of view.

Now, we will make a brief introduction to several visual, aural and haptic VR output devices. We will discuss their properties, different modalities for each of them, their components and features.

It is very important keep in mind that, in order to select one of the visual, aural or haptic options there are not a rule that say us which is the best choice. Depending on parameters like available resources, venue constraints and/or requirements, number of users of the virtual experience, etc, the designer of the VR system must make this choice.

3.1 Visual Devices

In the real world, when we look around, we perceive information regarding the relative distance of objects. In this process, this information is given thanks to several indicators of distance, also known like *depth-cues (monoscopic, stereoscopic, motion and physiological).* Not all these *depth cues* have the same importance but, undoubtedly, the *stereoscopic* is the most eminent. The stereoscopic image depends on *parallax*, that is, the apparent displacement of objects viewed from different locations.

Nevertheless, besides these *depth-cues*, they are also important other properties of visual devices that it is important keep in mind when we want to choose the appropriate visual device. These properties are the *Visual Presentation Properties* (color, spatial resolution, contrast, brightness, number of display channels, focal distance, opacity, masking, FOV –Field of View-, FOR –Field of Regard-, Graphics Latency Tolerance and Frame Rate), that they are a very important factor in the overall quality of the virtual reality experience, and the *Logistic Properties* (Portability, Encumbrance, Safety, Cost, etc.).

At present, technically is possible to produce a virtual visual sensation similar to the reality, also with the stereoscopic effect, that it will help to increase the realism and immersion of the user in the virtual experience. But, what devices will can to use for this? Basically, there are two categories of visual devices:

- *Head Based Visual Devices:*

Occlusive HMDs
Nonocclusive HMDs

- *Stationary Visual Devices:*

Monitor Based VR
Projection VR

- *Head Based Visual Devices (Occlusive and Nonocclusive HMDs):*

The *Head Based Visual Devices*, also know like *Head Mounted Device* (HMD), is the device that most people associate with Virtual Reality. All people, when they think in "virtual reality", they think in a HMD.

These devices have some screens that they move with the movements of the user head. These screens are small and lightweight since they are worn or held by the user. Most of the HMD allow stereoscopic image using, normally, a dual visual output (one for each eye) system.

Although these devices display the virtual world through the user's viewpoint, in these devices it is possible to add some tracking method and, also, some could have it incorporate in the unit. Tracking the location and orientation of the user head, the HMD can to be the most intuitive visual interface because, if a user wants to see another side of an object he will have simply walking to this new side and looking the object.

Occlusive HMDs:

These devices isolate completely the user from the real world. Anything the user needs to see will must to be generated by the virtual world, including this own body if this was necessary.

Nonexclusive HMDs:

These devices not isolate completely the user from the real world. They are used in order to obtain an augmented copy of the physical world, mixing, with the view of this real world, the view of a virtual world. That is, mapping virtual information onto the real world view. It is know like Augmented Reality (AR), a very important subclass of virtual reality.

In order to mix a virtual and a real image there are two methods: optics or video.

The first method uses lenses, mirrors and half-silvered mirrors. In the second method, where the images of real world are generated by cameras mounted on the HMD, is used electronic systems in order to make this mix [2].

The main advantages of these devices are the following:

- Lower cost for lower resolution models
- Can occlude the real world (useful in some virtual reality experiences)
- Can be used for AR
- Complete FOR
- Greater portability

The main disadvantages of these devices are the following:

- Limited resolution
- Limited FOV
- Encumbrance

- Stationary Visual Devices (Monitor Based and Projection VR):

These devices are known as "stationary" because they are fixed in place and unlike previous systems, they can not be moved with the user head movements in the virtual experience. Basically there are categories:

- Monitor Based VR
- Projection VR

Monitor Based VR:

Normally, this visual device is an extension of a simple desktop computer (standard computer monitor) setup but it requires other additional components in order to be considered a monitor VR. Basically, a monitor VR should provide the user to move their head (side to side and up and down) in order to see around, over and under objects and to see the virtual world in a stereoscopic way.

In order to track the user's head and, in this way, to render scene changes in response to the tracked head users movements, it is possible to use a monitor-top video camera that it will be useful in order to capture the images of the user head, to process these images and to calculate the location of their head. This system is an inexpensive system (sometimes it might already be part of the computer system), but it is possible to use other tracking technology too.

In order to obtain stereoscopic vision in the monitor VR is used a time interlacing system that it provides left and right view. The user will need to use a shutter glasses with liquid crystal display (LCD) lenses. Other possibility is to use some special filter over the monitor screen. This option avoids the use of special glasses.

The main advantages of these devices are the following:

- Inexpensive
- Easy to use
- Higher visual resolution

The main disadvantages of these devices are the following:

- Less immersive (than most other VR visual devices)

- Limited FOR

Projection VR:

This system uses large screens in order to visualize the virtual experience. This large visual "surface" can be created by setting several CRT monitors side by side but, normally, is used wide screens on which it is projected images by means of projectors like in the cinema. In this last option, the users are placed between the projector and the wide screen which can produce shadows of the users on the screen. An alternative to this is the use of rear-projection screens. In this option, the users are not between the projector and the wide screen avoids the annoying shadows. Now, most projection VR systems are rear-projected.

In order to track the user's head and, in this way, to render scene changes in response to the tracked head users movements, it is possible to use some of the tracking systems well-known. Nevertheless, it important to keep in mind this question: if the screen of projection is not vertical (normal in some specific projection systems) and it is necessary to provide to the user a stereoscopic vision, the system will need a greater range of tracking, plus head-orientation data.

In order to obtain stereoscopic vision in the projection VR system is possible to use two methods: shutter or polarized glasses. The first option is easier to implement because most graphical displays already include the necessary hardware. The second option can need a projector (specialized) or two projectors (regulars) equipped with filters to polarize the two images (left and right) for the appropriate eye. In this case, the user will need a pair of glasses also equipped with polarized filters.

The main advantages of these devices are the following:

- Wider FOV
- Greater user mobility (fewer cables)
- Longer periods user permanence
- Lower safety risk
- Better for group viewing

The main disadvantages of these devices are the following:

- Necessary more maintenance and equipment

Therefore, because the visual sense is the first sense used in order to obtain the immersion of the user in a virtual reality experience, it is very important to choose the appropriate visual devices if we want to obtain the goal of our virtual environment.

3.2 Aural Devices

In the real world we hear sounds on all sides. Thanks to the *localization* phenomenon, the brain of the listener can determine the direction and distance from which a sound emanates and, therefore, the listener can to understand the nature and features of the environment he is in.

Normally, the virtual worlds represent 3D environments like the real world. It is possible to create in a virtual world a virtual illusion similar to the *localization* phenomenon of the real world? The term *spatialization* describes this possibility. The *spatialization* is the act of creating the illusion that a sound is emanating from a specific 3D location.

This virtual illusion is possible thanks to the *Transfer Functions*, mathematical transformations that can be applied to a signal to alter it in some specific desired way. In this way, if a virtual reality experience developer wants to make that a sound is coming from a specific place in a virtual world, he will can to use some specific transfer function (filter) in order to obtain that the user perceives that the sound came from this specific place.

At present, technically is possible to produce this real sensation that it will help to increase the realism and immersion of the user in the virtual experience. But, what devices will can to use for this? Basically, there are two categories of aural devices:

- *Head Based Aural Devices:*
  Headphones

- *Stationary Aural Devices:*
  Speakers

- *Head Based Aural Devices (Headphones):*

Headphones are for one person only and move with the user head. They can to isolate in the user the sounds of the virtual world from sounds of the real world (Close-ear Headphones) or to overlap the virtual and real sounds (Open-ear Headphones).
Generally, these devices are dual-channel displays located near each ear. Therefore is much easier to carry out the presentation of stereophonic and 3D spatialized sounds that using speakers. In order to obtain that the user of a 3D virtual world has the sensation that the sound in this virtual world appear to come from a particular location, it is very important to track this head position so that the spatialization information reflects the changing location of the listener's ears.
The main advantages of these devices are the following:

- Works well with Head Based Visual Displays
- Easier to implement spatialized 3D sounds
- Isolate sound of the real world
- Greater portability
- Private

- *Stationary Aural Devices (Speakers):*

With the speakers, the sounds can to be listened for several persons at the same time. To create spatialized sounds using this technology can be more difficult than with headphones.

Ambisionics, the term that define the presentation of 3D sound using several speakers, it is a line of investigation that will may result in a usable system in the future [3].

Nevertheless, because both ears can hear the sounds from each of the speakers, to obtain this it don't seem an easy task.

The main advantages of these devices are the following:

- Works well with Stationary Visual Displays
- Greater user mobility

Normally, when a designer and developer of VR systems are planning a VR experience, they give much importance to the visual aspect of this experience: the realism of the virtual environments (3D models and textures) and the visual device that it will used.

Nevertheless, sometimes, the addition of high-quality sound in a virtual world can help in creating a compelling experience, a more realistic and immersive virtual experience, even when the quality of the visual presentation is not enough or the visual device selected is not the more appropriate. Both high-fidelity audio devices, headphones and speakers, are not expensive and, moreover, their incorporation in a VR system is very easy.

Therefore, it is necessary to give to the audio devices as importance as the visual devices because, both are essentials in order to add realism and immersion to a virtual experience.

3.3 Haptic Devices

In the real world when we touch something (object) we comes to believing this object is real and, therefore, this object exist. The existence of an object is verified by touch sense, the "haptic perception". It is very important to clarify that this perception involves two combined sensations: *kinaesthesia* and *taction*.

Kinaesthesia is the perception of movement or effort from within muscles, tendons and joints of the body. Normally, the term *force feedback* is used as a synonym of kinaesthesia.

Taction is the sense of touch that comes from the nerve sensors at the surface of the skin, that is, stimuli for temperature as well as pressure. In the human body, the reception of the *kinaesthesia* and *taction* information is produced at the same time. The separation of both processes is impossible.

Maybe, in a next future, it will be possible to combine both senses in an only device.

Nevertheless, at present it already is possible already obtain some of these sensations by means of haptic devices and, sometimes, their use in virtual worlds is extremely effective.

Therefore, technically is possible to produce a virtual haptic sensation that it will help to increase the realism and immersion of the user in the virtual experience. But, what devices will can to use for this? Basically, there are two categories of haptic devices:

- *Tactile Devices*

- *End-Effector Devices*

- *Tactile Devices:*

These devices use the ability of the skin in order to interpret stimuli as pressure, temperature, electricity and pain. They provide to the user information in response to touching, grasping, feeling surface textures or sensing the temperature of an object.

In order to present these stimuli to the user, several *actuators* are affixed to a wand that it will be grasped by the user hand because the tactile nerve sensors are located in the fingertips. These actuators will can to be *bladder actuators* (pockets that can be expanded

and contracted by controlling the flow of air or liquid into and out of them) or *vibrator actuators* (more robust and easier to control than previous). Both are used in order to translate the sensation of pressure.

These devices are not very advanced because the market for them is small and, therefore, less research is done on this field.

The main advantages of these devices are the following:

- Facilitates the fine manipulation of virtual objects
- Can be combined with end-effector displays is specific applications
- Often less expensive than other haptic devices
- Generally portable

- *End-Effector Devices:*

Normally, these devices act as input and output devices. Basically, they are mechanical devices that allow to the user to perform a force by means of one of their extremities (hands and/or feet) and, moreover, to provide him a resistance to this force.

An end-effector device need two components: a way of sensing the movements of the user and a way of providing resistance at the point of contact with him. In order to obtain this it is necessary using electric motors and hydraulics and pneumatic pressure systems.

Moreover, if we want to obtain a fast and accurate response it is possible to incorporate some mechanical user-tracking system in the mechanical devices in which are mounted these devices.

These are some examples of end-effector devices: *Argonne Remote Manipulator* (ARM) (multijointed hand grips), *PHANTOM* (desktop point controls), *Sarcos Uniport System* (resistive push and rotate pedals) and *Rutgers Master I and II* (hand-motion limiters).

The main advantages of these devices are the following:

- Can be world- or body-grounded
- Fast and accurate tracking usually built into device

Therefore, at present it is possible to offer to user tactile or force stimuli incorporating haptic displays in the virtual reality system and, in this way, to increase the realism and immersion that supposes the inclusion of virtual objects in a virtual experience.

Nevertheless it is very important to say that it will be necessary to choose if we want to offer tactile or force stimuli because, most commercially available haptic displays provide either tactile or force stimuli but not both.

4. Input Devices vs. Interaction

A distinction must be made between input devices and interaction techniques. Input devices are just the physical tools used to implement various interaction techniques. In general, many different interaction techniques can be mapped onto a given input device. The question is how naturally, efficiently, and appropriately a given input device will work with a given technique. Input devices are also governed by the degrees of freedom (DOFs) they

have. In general, an input device with a smaller number of DOFs can be used to emulate a device with more DOFs with the addition of buttons or modifier keys.

Input devices can be roughly categorized based on the types of events they generate.

Devices that generate one event at a time based on the user are considered discrete-input devices. A button press or other action signals an event, which is usually a Boolean (up/down) value. Pinch gloves, developed by Fakespace, are an example of a discrete-input device (the user pinches two or more fingers to signal an event). In contrast to discrete-input devices, continuous-input devices generate a stream of events. Two of the most common continuous-input devices are position/orientation trackers and datagloves, which transmit bend angles of the fingers. Devices that combine both discrete and continuous events to form single, more-flexible devices are called combination or hybrid-input devices.

Examples of hybrid devices include the Ring Mouse (a small device worn on the user's finger that combines ultrasonic tracking with two buttons) and pen-based tablets, which are becoming more popular in VE applications because they give users the ability to interact in two dimensions. Speech input is unique because the "device" is the human voice.

Speech provides a nice complement to other input devices and, as a result, it is a natural way to combine different modes of input (multimodal interaction). In general, speech input can be a valuable tool in 3-D user interfaces, especially when both the user's hands are occupied. A major myth of speech recognition is that having a good speech recognizer will solve all problems. Unfortunately, many other issues need to be considered when dealing with speech input. Letting the computer know when to listen to the user's voice is one such issue. A user may issue a speech command unintentionally when talking to another person. One of the best ways to avoid this problem is to use an implicit or invisible push-to-talk scheme. A push-to-talk interface lets users tell the application when they are speaking to it. In order to maintain the naturalism of the speech interface, one can embed the "push" into existing interaction techniques so the user does not have the burden of remembering the signal to the application that a voice command is about to be issued.

5. Interaction techniques

5.1 Navigation

The task of navigation is the most prevalent user action in most large-scale 3-D environments, and it presents challenges such as supporting spatial awareness, providing efficient and comfortable movement between distant locations, and making navigation lightweight so that users can focus on more-important tasks. We subdivide navigation into the motor component called *travel* and the cognitive component called *wayfinding*.

Navigation tasks can generally be classified into three categories. *Exploration* is navigation with no explicit target: the user is simply investigating the environment. *Search* tasks involve moving to a particular target location. Finally, *maneuvering* tasks are characterized by short-range, high-precision movements that are used to place the viewpoint at a more advantageous location for performing a particular task.

Travel is a conceptually simple task-the movement of the viewpoint from one location to another. Further, viewpoint orientation is usually handled in immersive VEs by head tracking, so only techniques for setting viewpoint position need be considered.

There are five common metaphors for travel interaction techniques, and most published interaction techniques for travel fit into one of these five categories:

- **Physical movement**: The user's body motion is used to travel through the environment. Examples include wide-area motion tracking, walking in place, and

locomotion devices such as treadmills or stationary bicycles, Such techniques are appropriate when an enhanced sense of presence is required or when the application requires the user to experience physical exertion when traveling.

- **Manual viewpoint manipulation**: The user's hand motions are used to effect travel. For example, the user "grabs the air" and pulls himself along as if with a virtual rope. Another type of technique uses a selected object as a center point around which user motion can be specified. These techniques can be efficient and easy to learn, but they can also cause fatigue.
- **Steering**: Steering is the continuous specification of the direction of motion. This is the most common travel metaphor and includes techniques such as gaze-directed steering (wherein the user's head orientation determines the direction of travel) or pointing (in which hand orientation is used). Steering techniques are general and efficient.
- **Target-based travel**: The user specifies the destination, and the system handles the actual movement. This may take the form of "teleportation," in which the user jumps immediately to the new location, or, preferably, the system may perform some transitional movement between the starting point and the destination. Target-based techniques are very simple from the user's point o of view.
- **Route planning**: The user specifies the path that should be taken through the environment, and the system handles the actual movement. The user may manipulate icons or draw a path on a map of the space or in the actual environment in order to plan a route. These techniques allow the user to control travel while he retains the ability to perform other tasks during motion.

Besides choosing a metaphor, other design issues for travel techniques include velocity control and the use of constraints or guides to aid travel.

5.2 Selection and manipulation

Interaction techniques for 3-D manipulation in VEs should provide means to accomplish at least one of three basic tasks: object selection, object positioning, and object rotation.

Because direct hand manipulation is a major interaction modality not only in the 3-D virtual world but also in natural physical environments, the design of interaction techniques for object selection and manipulation has a profound effect on the quality of the entire VE user interface.

The classical approach to design manipulation techniques is to provide the user with a "virtual" hand – a 3-D cursor, often shaped like a human hand, whose movements correspond to the movements of the hand tracker. Selection and manipulation simply involve touching an object, then positioning and orienting this virtual hand within the VE.

The virtual hand technique is rather intuitive because it simulates a real-world interaction with objects, but only those objects within the area of reach can be picked up.
A number of techniques have been suggested to overcome this problem. The Go-Go technique [4] allows the extension of the user's reach by using a nonlinear mapping applied to the user's hand extension. When the user extends the hand farther than a threshold distance D, the mapping becomes nonlinear and the virtual arm "grows". Different mapping functions can be used to achieve different control-display gain between real and virtual hands [5].

The other common way to select and manipulate objects in VEs is to point at them using a virtual ray emanating from the virtual hand. When the virtual ray intersects an object, it can be picked up and manipulated. Several variations of ray casting have been developed to help users in selecting very small or faraway objects. For example, the

spotlight technique [6] provides a conic selection volume, so that objects falling within the cone can be easily selected. However, when more than one object falls into the spotlight, further disambiguation of the target object is required. The aperture technique [7] uses a conic pointer whose direction is defined by the location of the user's eye (estimated from the head location) and a hand sensor. The user can control the size of the selection volume simply by bringing the hand sensor closer or moving it farther away. The image plane family of interaction techniques [8] develops and extends this idea.

All the techniques described above provide users with tools that allow them to select or reach further in the immersive virtual world. An alternative approach would be to allow the user to manipulate the relative scale of the virtual world. One of the earliest uses of this approach was in the 3DM immersive modeler [9], in which users could "grow" or "shrink" themselves to manipulate objects of different sizes. The World-in-Miniature (WIM) technique [10] provides a handheld model of the VE. The user can then indirectly manipulate virtual objects by interacting with their representations in the WIM.

Because all manipulation techniques have particular strengths and weaknesses, a number of attempts have been made to integrate and combine their best features. For example, the Virtual Tricorder [11] combines ray casting for selection and manipulation with techniques for navigation and level-of detail control within one universal tool.

5.3 System Control

System control refers to a task in which a command is applied to change either the state of the system or the mode of interaction. The issuing of a command always includes the selection of an element from a set. Thus, some similarities can be seen between system control and object selection techniques. In desktop applications, the use of commands has received much attention. Unfortunately, interaction styles used in desktop environments, like pulldown menus and command-line input, are not always usable within a VE. One of the basic problems of VE system control is that a normally one- or two-dimensional task becomes three-dimensional, which reduces the effectiveness of traditional techniques. For example, touching a menu item floating in space is much more difficult than selecting a menu item on the desktop, not only because the task has become 3-D, but also because the important constraint of the physical desk on which the mouse rests is missing. Evaluation results for system-control techniques are relatively sparse. Although many ad hoc implementations have been reported, system control has not been studied in a structured way.

We can categorize system-control techniques for immersive VEs into four groups, namely graphical menus (visual representations of commands), voice commands (menus accessed via voice), gestural interaction (command sets accessed via gesture), and tools (virtual objects with an implicit function or mode). Also, hybrid techniques exist that combine several of the types.

System control is often integrated within another universal interaction task. Due to this integration, one should avoid disturbing the flow of action of the main interaction task.

The user should stay focused on the task. "Modeless" interaction (in which the mode changes are very natural) is ideal. One way of supporting easy access to a system -control interface is to use a natural spatial reference, such as a fixed position relative to the user's head or body, for placement of the interface. This guideline is mostly applicable to graphical menus, but tools also benefit from a strong spatial reference. Another method to allow a more seamless integration of system control into a flow of action is to use a multimodal system control interface.

After accessing a system-control interface, one has to select a command. When the set of functions is large, one needs to structure the items. This might be achieved by

methods like context-sensitive menus, or by clearly communicating the hierarchy of items and (sub) menus.

Finally, the designer should try to prevent mode errors by providing the user with appropriate feedback during and after selection of a command. Mode errors can be highly disruptive to the flow of action in an application.

6. Two-Dimensional Interaction in Three-Dimensional Environments

A common misconception of 3- D user interface design is that, because the applications usually contain 3- D worlds in which users can create, select, and manipulate 3-D objects, the interaction design space should utilize only 3-D interaction. In reality, 2-D interaction offers a number of distinct advantages over 3-D interaction techniques for certain tasks. If haptic or tactile displays are not present, 2-D interaction on a physical surface provides a sense of feedback that is especially useful for creating objects, writing, and annotating.

Most efficient selection techniques are essentially 2-D, although further manipulation may require a 3-D interaction technique. By taking advantage of the benefits of both 2-D and 3-D interaction techniques, it is possible to create interfaces for 3-D applications that are easier to use and more intuitive for the user. Seamless integration of 2-D and 3-D interaction techniques is a critical design consideration from both a physical and logical perspective. Physical integration is important because we do not want to make it difficult for users to switch between 2-D and 3-D devices. Logical integration is also important because we want the devices in the application to know whether they are used for 2-D or 3-D interaction. This contextual application-based information helps to reduce the user's cognitive load.

The 2-D /3-D interfaces can be roughly classified into three categories. Note that, in all categories, some type of physical surface is required for 2-D input. The distinguishing characteristic of these interfaces is how the physical 2-D surfaces are utilized. The first category covers applications that use fully immersive displays such as HMDs, where the user cannot physically see the 2- D surface. Here, the 2-D surface is usually a piece of tracked plastic or pen-based tablet, and users must have a graphical representation of the surface in order to interact with it in the virtual world. Examples of this type are the Virtual Notepad, a system for writing and annotating in VR [12] and the Virtual Habitat [13].

The second category of2-D/3-D interfaces cover applications that use semi-immersive displays such as workbenches. The physical 2-D interaction surface is usually either on top of the workbench display so users can directly interact with the display surface, or on a tracked, transparent tablet that users can hold in their hand. In the latter case, graphics are projected on the primary display but virtually appear as if they are on the surface of the tablet. Examples of this category are the ErgoDesk system [14], a modeling application using the physical display surface for a 2-D interface, and the Transparent Pad, a clear tablet that users can hold to interact with a landscaping design application [15]. The third category uses separate 2-D display surfaces, such as handheld computers and pen-based LCD tablets. An example of this type of interface is the use of a Palm Pilot in a CAVE-like device for camera, environment, and geometry controls [16]. In this area, there are many open research issues to explore, especially when dealing with wireless technology and the weight of these devices.

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SECTION IV

CYBERTHERAPY ERGONOMICS: HOW TO DESIGN EFFECTIVE CYBERTHERAPY TOOLS

Although 21St century technology does not allow the level of realism portrayed in Star Trek, new research methods relying on virtual reality are changing the way we study the mind and brain, as well as how we apply the fruits of this research in the "real world". "It is not true that the laboratory can never be like life. The laboratory must be like life!" exclaimed the eminent perceptual psychologist J. J. Gibson in 1979. Inspired by this philosophy and by improvements in technology, we and others have created virtual reality laboratories to investigate how humans interact with their surroundings under more realistic conditions.

Tarr & Warren, 2002

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Cybertherapy
G. Riva et al. (Eds.)
IOS Press, 2004

11 Ergonomics of Virtual Environments for Clinical Use

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Abstract. Usability is defined by the International Standards Organization as "the effectiveness, efficiency and satisfaction with which a certain user may achieve a specific objective in a particular environment" (ISO DIS 9241-11). This definition highlights the need for considering the specific destination of a certain technology and reflects the current trends in Human-Computer Interaction (HCI). In compliance with these remarks, the evaluation will be described here of a Virtual Environment (VE) for the treatment of male sexual dysfunctions; the common assumption will be avoided according to which a VE is a space separated from its 'real' surroundings [6, 7] and the full environment where the Virtual session takes place will be addressed instead. After a description of the conceptual framework adopted, the paper will dwell on one method among those deployed for the evaluation, namely the analysis of 'situated actions'. Four aspects will be dealt with: (a) the interplay of various concurrent settings during the virtual session; (b) the users' comprehension of the symbols used in the VE; (c) the structure of the relationship between users and guide; (d) the breakdowns during the human-VE interaction. The goals and the intended meanings of the simulation as set by the designers became the main parameters for the evaluation.

1. The object of evaluation

This chapter illustrates the criteria for the usability evaluation of an immersive Virtual Environment (VE) developed within the European Project 'VEPSY updated'; it was directed to the treatment of male patients suffering from sexual impotence, part of a longer treatment carried out with several different methods (for a description of the therapeutic rationale see chapter 5.4 in this book). The version evaluated (which differs from the final one) contained no explicit mention to the clinical problem it was meant to treat; it was a three dimensional environment, containing four main paths [Note 1] in a large Mediterranean forest with grass, trees, flowers and other vegetation (Figure 1). As the session started, the patient was supposed to enter one of the four paths according to the therapist's suggestion and to go through several encounters of evocative meaning. He was sitting on a swivel chair, wearing the immersive gears (head mounted display) and operating on a joystick fixed on an armrest of the chair according to hand preference; the therapist sat next to him and watched the virtual environment from a monitor. Patient's and therapist's roles during the immersive sessions differed yet complemented each other: the patient performed the actual movements in the VE, described what went on and asked for

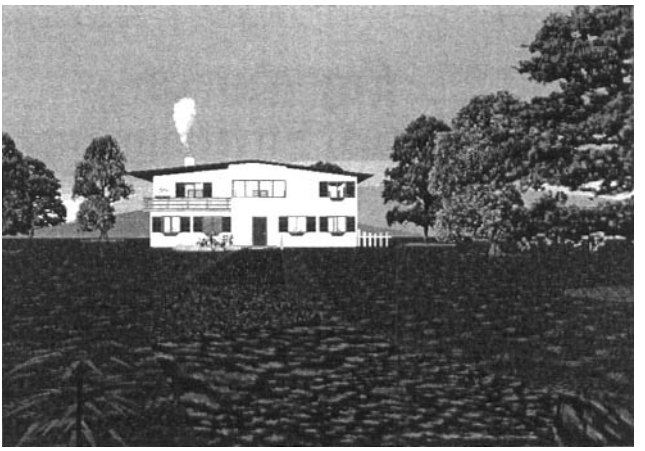

Figure 1. A view of the VE considered for the ergonomic evaluation

clarifications; the therapist chose the path, oriented the patient's behaviour and provided the 'correct' description of the events. The therapeutic environment was therefore created by the patient's and therapist's interaction with each other and with the technical equipment.

The peculiarity of this environment does not reside so much in the characteristics of the technology to be assessed as in the complexity of interactions taking place around it: in addition to the immersed user, the setting includes a non- immersed person, the therapist with a crucial role in the fruition of the VE: he intervenes on the patient's movements and mediates the interpretation of the events. As a further element of complexity, the experience has a symbolic dimension, whose readability is as crucial as the comprehension of the interface. Particular attention, however, has to be paid to the boundaries of the ergonomic evaluation, to exclude the clinical rationale embodied in the system. It is the therapist's responsibility, in fact, to validate the therapeutic method, while the ergonomic evaluation of the system should concentrate exclusively on its comprehensibility and on a satisfactory functioning.

A usability evaluation requires a model of human-computer interaction that offers clear definitions of the objects to be evaluated and a methodology coherent with the conceptual framework and the specific goals of the system. The usual constructs of ergonomic analysis, however, are not straightforwardly applicable in this case: who is the intended user, the patient or the therapist? Where does the action occur, on the simulation or on the therapists' cabinet? Which aspect of the system should be assessed, the operation on the interface or the symbolic meaning possibly conveyed by the three-dimensional environment? Given the complexity of the environment in which the immersive treatment is performed, an explicit theoretical reflection is needed in order to make the articulation of the system components explicit. This chapter will describe the framework that guided our evaluation and present some of the results obtained.

2. Conceptual framework: the hybrid environment of the VE in use

According to the International Standards Organization (ISO DIS 9241-11), a tool is usable when it allows "a certain user to achieve a specific objective in a particular environment with effectiveness, efficiency and satisfaction". This definition invites to avoid generic assessments and tune the usability of a tool to the precise requirements of the activity to

which it is destined. The current trends in the field of human-computer interaction (HCI) [1, 2, 3, 4, 5], in fact, highlight the strict connection of a tool with its context of use. This represents the most recent stage in a historical progression through at least three different units of analysis [17, 18]. In a first stage, usability evaluation concentrated mainly on the technical features of the system (hardware reliability, software robustness, comfort of the interactive devices) and was carried out on the basis of engineering practices and norms. At this level, the object of evaluation was the functioning of the system as a technical product.

In a second stage, the interface mediating the exchanges between humans and the system became the focus of the analysis, to asses whether the characteristics of the interface met the characteristics of the human cognitive processes or not [6,7]. The possible errors in perceiving, understanding and operating on the interface were examined [8, 9].

Eventually, a third approach has brought to the foreground the context in which the tool is used, made of various social, cultural and infrastructural resources; the analysis is carried out on actual episodes of interaction of the final users with the technology [1, 10].

This latter stage has also modified the way in which the earlier objects of usability evaluation (the technical characteristics and the interface) are considered. As several research streams in HCI have claimed (Situated Action Theory [1], Activity Theory [11], Workplace Studies [12] Scenario-based Design [10], Distributed Cognition [13]), it is not possible to make reliable predictions on the introduction of a new technology on the basis of technical considerations alone. Technologies have been re-described as 'symbolic' objects as well as technical ones [14, 15], because a tool makes sense only when its technical properties are interpreted by the users. At the same time, the psychological properties of the individual user are not exhaustive descriptors of those 'symbolic' elements, because the whole system of activities, priorities and relationships would remain excluded [16]. The 'human factors' of the ergonomic tradition are re-located within the broader scenario of material, cultural and social resources [18].

When it comes to the evaluation of virtual environments, these remarks acquire particular relevance. In fact, the evaluation of VEs still tends to be carried out from a rather outdated perspective, where engineering criteria and classic human factors are considered as the only elements influencing the satisfaction and effectiveness of the immersive experience, and the context of use is treated as a marginal or disturbing element [19, 20, 21]. This is probably due to some presuppositions according to which a VE should provide a synthetic, illusionary world competing with the real one as a robust domain of experience. The ISO definition encourages the evaluator to consider the actual environment created by the use of the VE [23], and to take into account the various cultural, infrastructural and social resources structuring the immersive experience. Therefore, a different perspective is taken in our evaluation, where the VE is considered as a field of possible actions centered but not limited to the three dimensional graphic simulation alone [22, 29] experience.

Figure 2 offers a schematic view of the VE in use, a hybrid environments gravitating around the action in the simulation and including various resources: (a) the user's relationship with the technology, (b) other people's relationship with the technology (in our case, the therapist), (c) the user's relationship with the other person and their conjoined interaction with the technology (d), the physical setting where the session is hosted. These elements represent the immediate, local context of the technology in use. In addition, the use is influenced by macro-dimensions, such as the cultural and the institutional ones, via the usage practices and the goals that take part to interaction with the VE. This combination of resources develops dynamically and can give rise to multiple solutions, as varying goals and practices emerge or the user is also involved in other settings.

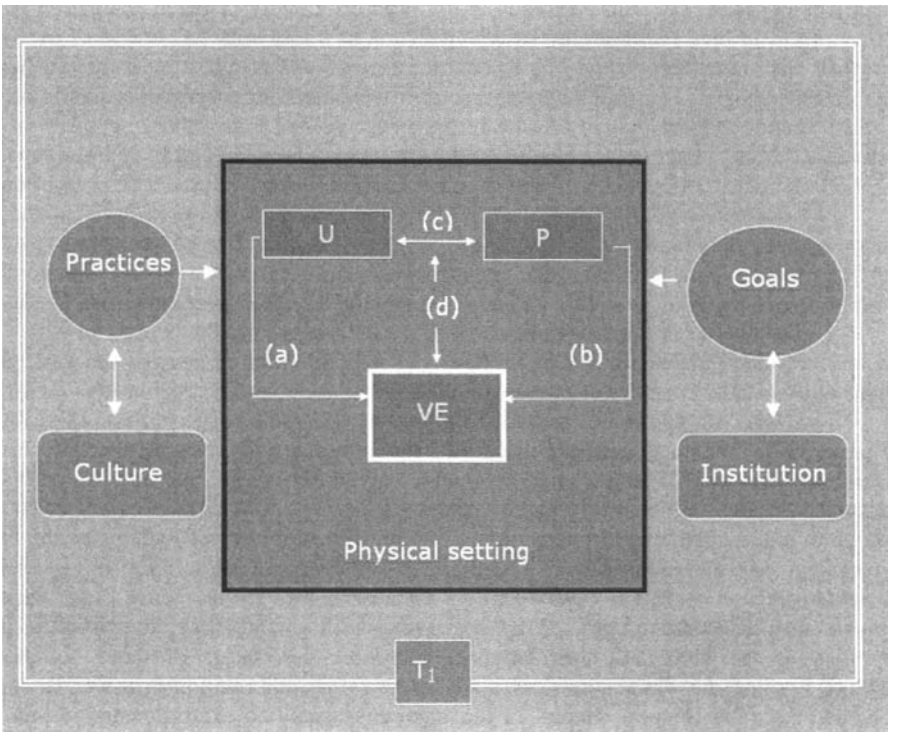

Figure 2. A schematic representation of the hybrid environment of the VE-in-use at a certain moment in time (T_1) with the user (U), the Virtual Environment (VE), other people (P)

As the model illustrates, the environment in which the VE is used is composed by several elements intertwined, not only by the user's relation with the interface; thus only by considering those elements together can we have a realistic depiction of what is the actual use of VE.

3. Methods

Once the characteristics of the VE in use are outlined explicitly, we had to set out an evaluative methodology sensitive to the theoretical framework adopted. Three methods have been chosen: two classic ones, pluralistic cognitive walkthrough and expert evaluation [24, 25], and a more recent one, inspired by Discourse and Interaction Analysis [26, 27].

'Pluralistic cognitive walkthrough' consists of asking people with a different perspective on the system to engage in a task scenario; in the version elaborated here, one participant is immersed in the virtual environment, while the other is observing the interaction on a monitor. They are asked to carry out a task together and to comment on the characteristics of the virtual environment relevant to them. 'Expert evaluation' consists in having the system studied by an expert, who is requested to evaluate each individual element with reference to a list of design principles. Experts were invited to navigate the virtual environment and report on any possible source of human error they could figure.

Comments were collected by the evaluators on the minimal system configuration required, the technical functioning of the interface (input/output devices, requirements,

frame speed, tracking system), the perceptual precision of the graphic, the smoothness in the navigation and the quality of the multimedia simulation.

The third method was meant to address the symbolic and social components of the VE-in-use and will be described in the rest of this chapter. The unifying element of the hybrid environment sketched in Figure 2 above is not the physical environment, nor the digital one, but the action in the VE which is the reference point for the other components of the model; for this reason, Discourse and Interaction Analysis have been adopted as the third method, for they take the action performed in a certain situation, or 'situated action', as their unit of analysis. In this tradition, action is either verbal (reminiscent of the speech act theory according to which people do things with their words) and non-verbal; a phenomenon of interest is studied by observing the way in which it emerges from the sequence of actions. To avoid hermeneutic speculations, the analysis is substantiated by what is demonstrably done by the users. Finally, its heavy reliance on the sequential order of the events and on the contingencies of the action meets our theoretical attention to the dynamic context of the VE-in-use.

4. Data collection procedure

The evaluation procedure tried to approximate the real usage procedure but the clinical treatment itself was kept out of the testing, since we were not entitled to any intervention of clinical nature. Thus, participants were not reportedly suffering from sexual impotence and a researcher played the role of the guide according to a usage protocol drawn up in collaboration with the therapist. In the following paragraphs, instead of 'patient' and 'therapist' we will then refer to 'users/participants' and 'guide/ researcher/ experimenter'.

The evaluation procedure involved 4 male students, aged 19 to 23 years. They were all students in psychology with normal (or corrected to normal) vision. Before the immersive experience, they were all asked to fill in an informed consent form. At the same time, their "awareness" of the goal of the system was manipulated by letting only half of them read a description on the whole therapeutic protocol of which the virtual immersion was a module. The immersive session remained the same for the two groups, since no direct mention to sexual issues was contained elsewhere in the VE. In this way we could observe if awareness of the clinical goal affected the understanding of the simulation; for example, "aware" (or *contextualized*) participants could perceive more easily and correctly the symbols present in the simulation.

The immersive session was divided in 3 parts, one for each rout available, with pauses between them [Note 2]. The sequence of interaction with the technology was videorecorded with the 'split screen technique' [30], thanks to which the events taking place both inside and outside the virtual environment appear in parallel on the same screen. After the session, all participants were asked three questions: *1. What meaning do you give to this experience? 2. How did you feel during the session? 3. How do you feel now?* All video-recordings of the sessions and audio-recordings of the interviews were transcribed. The analysis was carried out with the third method described above, inspired by discourse and interaction analysis, on the following aspects:

a) The interplay of various concurrent settings: the intent was to see if there were different environments in which the action of the user could be located and if any interference among them could reduce the usability of the VE;
b) The users' comprehension of the symbols and the role played to this respect by the awareness of the specific therapeutic goals of the system;
c) The structure of the relationship between user and guide;

d) The breakdowns occurring during the human-VE interaction.

Let's consider these points in detail. Point (a) was addressed by examining the users' speech during the session and in the post-session interview to find any reference to the nature of the activity he was engaged in.

The criteria according to which point (b) and (c) could be evaluated were provided by the therapist who wanted the VE to '*enhance the patient's self-confidence* and *create a shared experience where the patient could feel supported and accompanied*'.

Consequently, the analysis of the interaction (c) was directed to verify the coherence of the usage procedure with the intended 'sharedness' and 'supportivity' of the whole experience, by examining:

- who had the initiative of a certain activity,
- who made the decisions,
- who initiated the correction of inappropriate actions,
- which actions were interrupted and continued by the other person,
- how consistent was the distribution of control between P and T throughout the session and how smooth their collaboration (ready responses to the other's prompts),
- who provided the interpretation of the events and how open to negotiation such interpretation was,
- how able was the guide to anticipate doubts.

To evaluate the users' comprehension (b) of the system, a list of the expected meaning of the objects along with the expected sense for each route in the session was obtained from the designers and used as a reference (see Table 1 below).

Table 1. A list of the expected meanings of the objects in the three routes

First part:	*(participant should refer)*
1 kitchen and living room	To feel at ease, in a comfortable place
2 toys	To sensations related to childlike experience
3 see-saw video	To loneliness or, on the contrary, to contact with other people.
4 Tower in the garden	To a sensation of anxiety, curiosity or indifference with respect to entering the tower. Consider whether they stopped in front of the tower or hesitate before entering.
Second part	
5 sword	To the object as a symbol of power and virility, to which they might be not interested.
6 old man	To him as a hold wise man, symbolizing disinterested help
7 Male characters	To the comparison with people of their own sex.
8 female characters	to encounters with the other sex
9 Women offering fruit	To a prize for having defeated the enemies
10 throne	Victory and, thus, to a prize related to the power reached through enemies' defeat.
11 cormorant	To success in achieving the goal
Third part	
12 first girl	To active involvement in helping the girl, symbolic of the capability and the acquired confidence in helping the other sex
13 second girl	To a feeling of confidence in relating to the other sex

Reference to the meaning of the symbolic objects and to the sense of the routes were looked for in users' speech during the session and the interview (Table 2) to establish if they were totally, partially or not consistent at all with the expected ones.

> *1st part of the session*: The participant does not refer to the concept of childhood.
> What is observed is *inconsistent* with the initial expectations concerning the general understanding of the path.
>
> *2nd part of the session:* The participant defines this experience as a 'social' task (22:07), characterized by positive and negative interactions (22:10) with respect to a not well identified aim (22:38).
> This observation is *consistent* with the initial expectations concerning the general understanding of the path.
>
> *3rd part of the session:* The participant does not explicitly refer to this criterion, but his argumentation contains some indexes that the situation is perceived as more complex than the previous ones, as it involves social aspects (13:3)
> This observation is only *partially consistent* with the initial expectations.

The results were finally reported in a table and the aware/non aware users compared.

As to point (d), the goal was to analyze the spontaneous problems that emerged during the usage of the system. The rationale for identifying such episodes in the video-recordings was to start from an interruption in the action flow and stop when the broken course of action was restored or abandoned. 'Breakdowns' here were not only technical breakdowns of the system, but more generally any breakdown in the interaction with the VE, wherever the cause was located, either in the simulation or out of it [28]. The discrepancies in the action flow reveal some inadequacy in participant's action and are analyzed with respect to the context in which such inadequacy comes up.

The results were finally reported in a table and the aware/non aware users compared.

5. Results

5.1 The interplay of various concurrent settings.

From the analysis of participants' comments and speech, we distinguished three possible descriptions of the experience: therapy for sexual dysfunction, the actual storyboard (narrative) of the simulation and the VE as an entertaining device. During both the simulated sessions and the post-session interviews the *narrative* was generally recognized whereas the *sexual implications* were scarcely mentioned. The experience was frequently interpreted as a projective test or in terms of everyday life situations (the enemies stand for any kind of adversities one can find, not just male competitors; the throne was seen as the risk of resting on one's laurels).

The reference to the VE as *entertainment* was manifest in comments such as: "nice experience", "interesting", "peculiar", "new", "weird", "magic potion", "story", "adventure", in the recurrent characterization "curious" in reply to the question "how did you feel?" and in the appreciation for the "fun" of some episodes, such as the "fight" against the boys. Participants often mentioned the realism of the environment (noting also some incongruent elements such as the ocean in the middle of a country landscape or a sudden disappearance of the path) or of the performance (the trial, the adventure per se).

Table 2. A copy of the evaluator's notes where the points in users' discourse are indicated in which some reference is made to the symbols

1. kitchen and sitting room: The participant does not refer specifically to kitchen and sitting room; however, he says that the house, in general, transmits him a feeling of safety (18:16). What is observed is only *partially consistent* with the initial expectations.
2. toys: The participant does refer neither to toys nor to childhood. This fact is *inconsistent* with initial expectations.
3. see-saw video: The participant refers to the see-saw video as an element not well integrated in the environment (17:7). This observation is *inconsistent* with the model's expectations.
4. the tower: The participant refers to a strange sensation, related to tension (17:23-25) before entering the tower, as he doesn't know what to expect, justifying this perception with a feeling of uncertainty that the shape of the tower (narrow and long) causes to him (18:15-21); anyway, he does not hesitate in entering. He sets this anxiety against the sensation of pleasant curiosity felt before entering the house and the subsequent perception of safety and control during the exploration of the house itself. Despite the strong emotions experienced with regards to the tower event, he is not able to supply an explanation of the possible symbolic meaning of the tower itself: he claims to have guessed that the tower has a specific meaning, but he thinks not to have understood its sense. (18:8,9) What is observed is *largely, but not completely,* consistent with the initial expectations.
5. the sword: The participant does not refer neither to sword nor to power. This observation is *inconsistent* with the expectations of the model.
6. old man: The participant refers that the old man helps in resolving a difficulty (22:13). This observation is *in line with* the initial expectations.
7. enemies: The participant defines the interaction as a negative one, based on the way in which they are named (enemies) and on the type of action suggested, that is their elimination (22:10,19) This observation is partially *in line with* the initial expectations.
8. women: The participant refers to them as figures having a dull effect (23:34), or with reference to the positive character of the interaction. (22.21) This observation is *only partially consistent* with the initial expectations.
9. Women offering fruits: Girls offering fruits are cited by the participant only as human figures in motion, and thus characterized by a fake effect (23:34). Anyway, the interaction is positive (22:21). This fact is *inconsistent* with the initial expectations.
10. the throne: The participant does not make any reference of this kind. This fact is *inconsistent* with the initial expectations.
11. the cormorant: The participant defines it as a 'see bird' and, thus, as difficult to be interpreted in the context of the preceding social interactions (I'm not able to understand how does it make sense in that framework; (22:24); It is defined as part of a contemplative-like experience. This observation is *inconsistent* with the initial expectations.
12. first girl: The participant does not make any reference of this kind. This fact is *inconsistent* with the initial expectations.
13. second girl: The participant does not make any reference of this kind. This fact is *inconsistent* with the initial expectations.
14. couple: The participant does not make any reference of this kind. This fact is *inconsistent* with initial expectations.

In synthesis, the awareness of the specific therapeutic goal of the sessions helped some participants to clarify what happened but remained quite hidden, which is of no surprise since our participants' were not, by design, 'patients' undergoing a sexual therapy. The entertaining nature of the experience enriched participants' use of the VE and made it pleasant.

5.2 Users' comprehension of the symbolic meanings

Overall, non-contextualized participants showed a modest comprehension of the symbolic value of the object-events encountered; likewise, they showed a modest comprehension of the three routes of the immersion. References to the expected meaning were vague and indirect. Contextualized participants, instead, showed a better grasp of the meaning of the object-events, although not an excellent one. With respect to the routes, one of them showed a good alignment to the intended meaning, the other one an indirect one (Table 2).

The clarification of the nature of the symbols is required, to isolate them from other aspects equally noticed by the participants. Anecdotically, a participant engaged in the cognitive walkthrough, where no guide was present, did not consider the movie with a man walking hand in hand with a girl at the end of the session as a representation of himself with the girl, but of someone else who 'stole' the girl from him.

Table 3. The consistence of the perceived meanings with the expected ones (0= no consistency, 1= partial consistency, 2= full consistency)

	Participant 1 (not contextualized)	Participant 2 (not contextualized)	Participant 3 (contextualized)	Participant 4 (contextualized)
1st route	1	0	1	2
2nd route	0	2	2	2
3rd route	0	1	1	1
kitchen and living-room	0	1	1	1
toys	1	0	1	.2
see-saw video	0	0	0	0
tower	0	1	2	2
sword	0	0	2	2
old man	2	2	2	2
enemies	0	1	0	2
women	0	1	0	1
women offering fruits	0	0	0	0
throne	0	0	0	1
cormorant	0	0	0	0
first girl	0	0	0	2
second girl	0	0	2	2
couple	0	0	0	0

T: what do you see?
()...
P: a kitchen, I'm going to the kitchen,
T: *turns his chair to the right*
P: °ok° (.) the stove,
T: (*moves his chair to the right*)
P: moves forward
P: there is a sink, a couple of windows,
T: *turns him to the right*

Figure 3. An example of the interaction between guide and participant.

When informed of the goal of the clinical system, users considered the experience quite plausible. The relaxed tone of the experimenter, the music and the narrative contributed to mitigate the unease possibly engendered by the novelty of the experience, but for sure the therapy framework, better than the narrative alone, provided a meaning to the experience, which on the contrary kept escaping non-contextualized participants. After the first part of the session, all participants' comments referred somehow to the 'strangeness' of the experience; after the second and third part, however, only non-contextualized participants kept on referring it.

5.3 The relationship between users and guide.

The protocol succeeded in directing the participants during the virtual journey: video clips left no other choice but watching them, to the point the participants sometimes complained about their passive role; the experimenter rotated the swivel chair to correct the movements of the participants throughout the whole session and changed their visual field, solicited the desired action and anticipated the events to be focused on. Participants aligned to the expected kind of conduct and asked for permission before taking initiatives. The guide decided the actions to perform, the participant followed his suggestions; the former initiated the descriptions, the latter completed them (as in the passage shown in figure 3).

Misunderstandings were usually identified by the experimenter who was the one to initiate repairs, thus confirming his/her role as expert in the situation.

5.4 Emerging breakdowns during human-VE interaction

Among the most recurrent breakdowns observed, there were the following:

- Video clip onset. Presumably, the activation area of the video clips surrounded the object to which they were associated so that, when objects were approached, the related video clip started. The problem was that – being the activation area 360° degrees wide with respect to the objects - videos became active even if the objects were not actually present in participants' view. In those cases, the logic connection among object and video clip was missed.

- Interruptions in the video clip of the running girl. This video clip contained a couple of interruptions during which the participant was suddenly transported back in the country landscape for some tenths of a second. Since the participant was invited by the narrative to 'follow' the girl, the interruptions were devised to enable him to move forward, since no movement was possible while the video clip was running. Yet, the connection was barely apparent and a sense of passivity prevailed.

- Instructions could be improved by anticipating the events, thus preventing too many questions from interrupting the smoothness of the experience. It would also be useful to base instructions on elements that are currently visible in the landscape, to avoid further confusion. Sometimes, actions were announced in the narrative that could not actually be performed by participants, thus engendering some misunderstandings. For example, after instructions like 'let's take this sword' or 'there is a sword over there', participants tried to turn to the sword and/or to reach it, although the sword was automatically owned just by passing by it. Finally, the shared nature of the experience could be *more clearly* addressed by controlling the way pronouns were used in the instructions (plural versus singular) and by making the representation of the participant more coherent, since sometimes the view was egocentric, sometime body parts were visible (when handling the sward or holding the cup), sometimes the user was embodied by a fully visible character in the landscape.

6. Conclusions

Besides the specific list of remarks collected from the evaluation and turned to the coordinators of the project, a general conclusion can be drawn on the satisfaction and effectiveness of the VE with respect to its declared goal, namely to '*enhance the patient's self-confidence* and *create a shared experience where the patient could feel supported and accompanied*' . The first goal was facilitated by the processes of familiarization with the virtual environment, by the contextualization to the goal of the session and by the protected nature of the experience. The second goal was facilitated by the synchronic collaboration between experimenter and participant and made possible by the scaffolding function of the protocol, even at the risk of designing a very passive role for the user.

The evaluation of the VE usability, provided a chance to define and apply a broadened model of VE in use. The methods we adopted have triggered a subsequent series of efforts towards mixed quantitative and qualitative methodologies for the analysis of the social and symbolic aspects of a VE. The adoption of action as the unit of analysis provides a recent interpretation of the classic 'user-centeredness' invoked in ergonomics, since it can capture the details of the interaction and represents a direct source of information, sensitive to actual structure of the interaction and of the resources that shape it. Within the appropriate conceptual framework, whose clarification we tried pursue as a necessary condition for a good methodology, situated action can be captured at various levels of details and in various formats [30].

7. Acknowledgements.

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8. Notes

1) Each of the four routes available in the VE showed a specific sequence of events and objects. The paths depart spatially from a starting spot towards different directions (figure 4) and develop as follows:

ROUTE North: after turning twice, participants find themselves in front of a house. The house contains 2 rooms, a living room and a children-room full of toys. By exiting from the backdoor, participants can reach a garden with a medieval stone tower on the horizon.

ROUTE South: after a few steps, participants find a floating sword, which they can aquire by just passing by it. After that, there's a first bush. By reaching the bush, they start a full-screen filmed sequence, displaying a hand with a sword that tries to make its way through the shrub. Afterword, participants have to go through a second bush and watch another videoclip which is similar to the previous one except for a broken sword, shown in the last frame of the video. After a right turn, participants meet an old man figure, and a third video starts, where the old man offers a potion to the participant. As participants start walking again, they find another bush. Once the bush is entered, a fourth video starts. This video displays the same scene as the first one, with an unbroken sword. After that, there's a fork in the path. Participants are invited to go straight on and reach a forest. In the forest, participants see other six videos. Videos one and two display a blond woman dressed in white; videos three, four and five display a black-haired woman dressed in white. Video six displays a man (meant to represent the participant) and a woman, walking hand in hand.

ROUTE East: after a right and a left turn, participants find a group of male figures. Participants are invited to shoot them. After that, they find a short stepcase with a door at the top. Behind the door they find a group of female figures. Beyond the group, there are other steps with a throne at the top of them. Once the throne is reached, participants see two full screen videos displaying two women who offer them some fruits. After the throne, there's a fork in the path. Participants are invited to turn left and head for the town. To reach the town, they need to walk across a tunnel. In town, participants reach a fire-balloon, which starts to raise in the air and show the land below.

ROUTE West: This route is almost a labyrinth with some forks and three couples of columns. Participants are asked to reach all columns. When they take the wrong path, they have to restart from the last columns they reached

2) All routes except for the west one were evaluated, as agreed with the therapist.

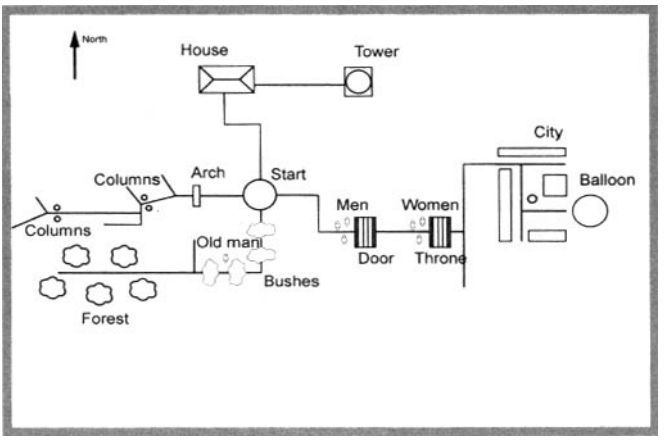

Figure 4. Bird eye view of the virtual environment

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12 An Integrated Approach to the Ergonomic Analysis of VR in Psychotherapy: Panic Disorders, Agoraphobia and Eating Disorders

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Abstract. To face the aspects connected with VR environments' usability for psychotherapeutic applications means to dare a double challenge from a methodological point of view: from one side, the need to adapt and to integrate on a heuristic basis classic usability evaluation methods to specific artefacts such as 3D Virtual Environments for clinical applications; from the other hand, the problems arisen by integration of expert evaluation of VR environments user-based tests carried out in real context of use. The theoretical background of our analytical stance is based upon an ethnometodological approach, a perspective that gives evidence of how people, in specific social situations, are able to solve complex tasks producing shared meanings and achieving their goals during interaction. According to this perspective, the methodological objective consisted also in the identification of the usability requirements of the specific *community of practice.* The virtual environments considered were two of the four VR modules in the framework of the VEPSY project: Panic Disorders – Agoraphobia and Eating Disorders.

1. Introduction

This contribution presents the work and the results of the ergonomic evaluation and the tuning process of the virtual environments (VEs from now on) used for the Eating Disorders Treatment.

The study reported has its first reference in the *"Functional description of the ergonomic characteristics of the modules"* in which have been summarised and analysed the results of the functional ergonomic evaluations of the VEs that were used in the small clinical trials carried out on the four demonstration modules of the VEPSY project. The VEs have been developed during the first 15 months of the project according to the needs of the clinical protocols proposed by the clinical group and the hardware infrastructure and the software chosen, after having discussed different solutions, by the technological partners.

On the basis of tasks assigned by VEPSY Project to our research unit, we didn't oriented usability analysis on telepresence evaluation. This task had been accomplished by clinical units, while we focused on functional features of VEs. As we'll show later, our main goal was to get usability evaluation of processes of use of VEs as performed by 'real'

users in 'real contexts of use'. This is the reason why after the *functional analysis* of VEs carried out, we operated what we could call a sort of *'fine tuning'* of the VR scenarios.

Since the VEPSY environments are designed for clinical use, to fulfil our goals, further steps were necessary after the basic functional evaluation:

- To establish a minimum threshold of ergonomic acceptability to be used for every VR VEPSY module, on the basis of specific indicators identified and reported in the Guidelines prepared at the beginning of the project

- To develop a new method of ergonomic and usability evaluation taking into account the requirements needed by the specific typologies of end users:
  - Psychotherapists
  - Patients affected by specific psychopathologies

- To integrate the results on the basis of the observations emerged after *Large Clinical Trials*: this implied a direct confrontation and a synergic collaboration with the clinical group

The basic assumption is that VEs should enhance the physical, cognitive and perceptual capabilities, allowing users to do things that are not possible – or 'not always possible', as for specific pathologies – in the real world. As stated by Mantovani [1], difference is not made by the realism of the experience but by the therapists' and patients' shared experiences as a whole, defining a clinical protocol to make use of the interaction and of the tools. As stated by Sutcliff, Gault and Shin [2], quality assessment of VEs has tended to focus on assessment of presence, trying to evaluate "how real or natural the user's experience was when immersed in the environment. Presence has been evaluated by questionnaires which ask users to rate various qualities of the VR environments ranging from perception of «being there» (Slater et al.) [3], to more detailed inventories ranking controls, feedback, perception of realism and user engagement". As we have already stated, telepresence was not a variable we had to evaluate. In addition to this, we didn't paid much attention to it because we share Sutcliff position on presence's measures when he says that they "can benchmark VE designs in terms of their realism and overall user experience" but "they do not help to diagnose design flaws for formative evaluation" [2]. For these reasons, in this paper we propose a set of heuristics and an expert evaluation method that, stemming from the evaluation of user interface, has been extended to VEs, with the goal to evaluate them in their real context of use. This assumption made the attention to be focused on two specific aspects:

- The consideration of areas of VR not yet completely explored from the usability point of view. For instance, the concepts of spatiality and representation (construction of meaning)

- The transfer of the results on the basis of a user-centred approach strongly applied to the real context

1.1 Scheduling of the ergonomic evaluation process

Our research unit conducted the ergonomic evaluation of two of the four VEPSY modules in 3 Phases:

1 **Panic Disorders and Agoraphobia modules**: in ***Phase 1,*** *guidelines on heuristic basis* were prepared in order to have an effective evaluation tool. Afterwards, usability test (observations) on generic users were carried out
2 **Eating Disorders modules**: in ***Phase 2,*** *basic functional requirements were verified,* referring to the results obtained in *Phase 1.* Then, usability tests (observations) were carried out on a different sample in comparison with the *Phase 1,* considering psychologists and non psychologists.
3 **Eating Disorders modules**: in ***Phase 3,*** *semi-structured interviews* were carried out on psychotherapists involved in the clinical trials of the modules considered.

1.2 A psychosocial integrated approach

The possibility to settle a research implant taking into account the cultural using context, the bargaining character of interaction and of its intrinsic 'opacity', represents the main methodological objective of this study. In particular, an ethnomethodological perspective is adopted.

As stated by Zucchermaglio [4], "Ethnography is one of the most adequate methods to enter communities by interpreting those meanings which are relevant for members in building up and interpreting the social world, looking for them in the discoursive interactions and in the public intersubjectively accessible behaviours. The validity of the ethnographic research is not to be found in the objectivity of the description, but rather in the level of authenticity, plausibility and reliability provided by the descriptions also to the observed subjects (...). We underline, for the comprehension of social situations, the importance of the *categories of meaning* performatively used by people involved in those specific situations".

1.3 The classic usability perspective

As emphasised by Cantamesse and Menti [5], the nowadays-considered usability is strictly connected with the evolution of ergonomics, term defining "a new method to study and to solve the relationship between the man and the working environment". The application field of ergonomics is rather wide: from the design of common use items to the user-computer and user-computer-user interaction with reference to the technologies. The viewpoint is a multidisciplinary one. Psychology and especially Social Psychology played a significant role in the evolution of the ergonomics towards a preventive rather than a corrective function. With the introduction of the prevention ergonomics the division between human error and machine as the relational concept has been adopted, centred on the relationship among persons, environment and tools used. From this moment on the artefact is considered as "an experience transformer": what was once defined as a task has become just a part of a wider scenario. Informatic artefacts became first of all "communication tools" and then "integrating part of the communication". In this development process, the concept of *usability* replaces the one of *reliability.* Since 1998 the definitions of usability suggested by the International Organisation for Standardisation (ISO 9242) evolved with stronger attention to the importance of the user even considering different experimental setting for the different subsystems: effectiveness, efficiency, satisfaction, understandability, learnability, operability [6]. Jordan [7] suggests a usability model including intuitiveness, learnability, expert user performance, system's potential, and re-usability.

As to the usability research methods now in use, Pedon makes a distinction between experimental and non experimental methods: the application choice is made upon higher or lower need to control dependent, independent variables and sample selection [8].

Techniques can be quantitative or qualitative. The quantitative ones give important information on the artefact failures or on the users' behaviour, but are not explanatory of the causes underlying those specific behaviours or of the services required. Qualitative techniques allow to analyse the whole interaction context including needs, aims and mental models. The *expert assessment*, aided by guidelines and checklists according to the heuristic evaluation, and the *user-based testing* [20], implemented with other techniques and tools such as interviews and focus groups, play the most relevant role.

Till now, despite intense and wide-spread research in both usability and VEs, there is no evidence that improvements in the first field could be applied to VEs' evaluation. As far as we know, VEs' new technology has not yet been closely and sufficiently coupled with the important characteristic of usability [9]. Too often we see usability evaluation methods of interactive computer applications, whose limitations are well-known, are adopted for evaluating VEs. And this is the reason why we think we need to develop usability evaluation methods and criteria *specifically* for VEs. As Sutcliffe has stated "few evaluation methods have been proposed for assessing the usability of VEs, although field studies of VR designers have demonstrated the need for HCI knowledge and methods" [2].Obviously, the point has been discussed by several papers: Gabbard and Hix, for instance, have tried to highlight usability problems associated with the use of VEs [10].

Bowman and Hodges, among others, have shown that the designers of VE systems cannot rely only on the methods developed for standard graphical user interfaces (GUIs) because of the fact that their interaction styles are totally different from standard user interfaces [11]; Johnson has tried to exploit design principles to generate heuristics to evaluate desktop VR applications [12] while Kalawsky adapted checklist evaluation methods, based on Nielsen's heuristics (1994), for VEs [13]. Generally speaking, most studies repertoried by Sutcliffe "have followed observation and expert interpretation of users' errors [14] or experimental studies reporting performance data and problems in a range of VE technology [15]". Nevertheless, we think that Gabbard statement [16] that "researchers interested in VE usability are left to performing ad-hoc assessment or in-house evaluations with little or no scientific basis for their approach" couldn't be kept today. In fact, we think that – thanks to recent developments in ergonomics studies – we now have almost all that is needed to develop a "a method to guide the usability evaluation of virtual environments".

In this paper we try to show how is possible to develop a psychosocial model of usability for VEs based on evidence of how people, in specific social situations, are able to solve complex tasks and produce shared meanings while completing these tasks in VEs in order to make their actions understandable and successful.

1.4 The analysis procedure: towards an 'ecological context of use'

To fulfil this goal we had to shift our attention from VEs in themselves to the relationships between users and VEs, focusing on how these relationships took shape in their real context of use. To approach the most ecological context of use, we turned to the LPP model (Legitimate Peripheral Participation): "Such a model considers the knowledge acquisition in progression terms – from the periphery to the centre - in the participation activities of the *communities of practice"* [17]

The study has thus been structured in three phases, each of them featured by:

- specific aims
- specific objects (i.e. two VEs typologies for different psychological disorders)
- samples reflecting aspecific, specific and professional ethnomethods
- generic, finalised and lived experience analysis contexts

Table 1. The research framework

Phase	Specific goals	Specific objects	Samples	Results	Analysis context
1	Functional characteristics	Panic Disorders Modules	**A** Generic users n=33	Aspecific Ethnomethods	Generic contextualization
2	Fine tuning	Eating Disorders Modules	**B** Psychologists /non psychologists n= 16	Specific Ethnomethods	Finalized contextualization
3	Integration	Panic Disorders Eating Disorders Modules	**C** Psychotherapists involved in clinical trials n=4	Professional Ethnomethods	Lived experience

2. Methods

The approach applied concentrates on identifying usability defects. Defects can be identified by expert assessment, aided by guidelines and checklists (heuristic evaluation) or by user-based testing (Nielsen, 1994) [18]. Moreover, classic usability methods have been integrated with specific ethnomethodological tools [19].

2.1 Main usability evaluation methods applied

Functional Analysis aided by expert heuristic evaluation: it is a type of analytical evaluation in which an expert in user interaction design assesses a particular user interface by determining which usability design guidelines it violates and supports. In this specific case this aspect was particularly challenging because, at present, there are very few guidelines specific to VR user interfaces.

To overcome this problem, the research unit prepared specific *Guidelines* to be applied to the expert evaluation and to the user-based tests. They were also designed with the aim to represent a flexible tool allowing further adaptation required by the different functional characteristics of the VR scenarios: for example, in Panic Disorders and Agoraphobia VEs, the evaluation of the commands toolbar was necessary, while in the Eating Disorders environments it was not present.

The heuristics used in this study are derived from Nielsen [20] and represent an attempt to consider areas of VR not yet completely explored from the usability point of view (i.e. spatiality: the use of spatial dimensions; virtuality: the sense of telepresence; representation: the construction of meaning) together with 4 indicators used to evaluate as many critical areas:

- Navigability
- Expected utility
- Communicative efficacy
- Graphic appeal

The *Guidelines* were intended to be:

- a reference tool for usability evaluation during the different phases of the modules implementation and tuning
- a supporting tool in identifying intervention priorities with particular reference to the interfaces
- a supporting tool to integrate modules in a coherent package
- a supporting tool for the definition of the characteristics of the final training activities
- a flexible tool for next evaluation activities concerning the final product

All along the study, we had to evaluate consistency and validity of the various heuristics we found out during the first analysis, as they resulted from the continuous regulation between users' performance's needs and minimum usability condition of each VEs. [21, 22].

Functional analysis performed in phase 2, for instance, is based on the reconsideration of the listed below critical points revealed by the consideration of VEs' 'navigability' and 'graphic appeal' in phase 1:

- movement control z axis
- collision control
- world's limits
- possibility of interaction
- anchorage of the objects

User-based test: it is a type of observational assessment with users that begins in the earliest phases of user interaction design and continues throughout the entire life cycle of the designing process. Qualitative data are usually in the form of critical incidents occurring while a user is performing task scenarios: they are events affecting user performance either in a positive or in a negative sense. Main focus of the research was to integrate this method with specific tool and by using different modalities in order to investigate the concept of VR usability in the real context of use. This goal was achieved gradually.

2.2 Specific tools

Classic usability evaluation methods have been supported by two specific ethnomethodological tools: *micro-narration* and *interviews*, used respectively in phase 2 and in phase 3. In the frame of the paradigmatic change under consideration, a relevant role is played by the narrative concept of knowledge and culture.

Narration can be considered both an adequate tool to recover shared practices, in particular, through recollection, and also a useful tool to create a group culture, that is to suggest a repertory of meanings determining what is important to observe in connection with consolidated habits. In the different phases of the analysis, micro-narrations and interviews were presented to subjects in order to recover information related to the co-interaction with the artefact and with the co-construction of meanings in a specific professional community.

Micro-narrations: users are supplied with specific information helping them to interact "*as if*" they were in the real context. For example: basic information about the specific VR protocol and about the therapeutic setting were given to the psychologists tested. They were informed that "purpose of the environments is not the creation of a perfect reproduction of the real world: patients and therapists involved are aware of the fact that

the effectiveness of the tool for the patient does not depend on the perfect accuracy of some specific elements but on the feeling of presence perceived that could be very different from the one of a person without pathologies".

Non psychologists users were asked not to consider VEs as videogames. They were explained the potential applications of the environments considered.

Semi-structured interviews: in-depth interviews with the clinical group (psychotherapists involved in the clinical trials) were carried out in order to move towards an ecological context of use. In the specific case, the investigation was focused on 4 main areas with reference to ergonomic aspects:

1 In context use of the VEs for psychotherapeutic sessions
2 Expectations of the therapeutic protocol
3 Usability (local interaction with the artefact, interpretation of the situation and context definition)
4 Towards a culture of use (possible future application of the VEPSY modules; critical aspects for training activities etc.)

3. The research

System characteristics:
Pentium III 750 Mhz - Windows 2000 SP 1- 128 Mb RAM – Hardware 13 Gb – Flatscreen 14" – Graphic board: Matrox G450 Dualhead
Headset: Sony Glasstron 800X600 – 75 Hz / Tracker: Intersense Intertracks 30

Phase 1
Modules: Panic Disorders - Agoraphobia

The *usability tests* were conducted on 33 subjects (16 immersive mode, 17 non immersive mode) belonging to both sexes, aged between 20 and 26. When building the sample the participants' degree of skill in navigating in VEs was not considered as independent variable.
Observation method: Thinking aloud (16 subjects) and Aided Interaction (17 subjects).
Time per session: 45 minutes
A *focus group* (5 subjects) was carried out after the tests.

Phase 2
Modules: Eating Disorders

The *Expert Functional Desk Analysis* (verification of the functional requirements) was conducted both in immersive and in non immersive mode on the basis of the results

Table 2: Panic Disorders and Agoraphobia usability test – Sample A

	IMMERSIVE MODE		NON IMMERSIVE MODE	
	Thinking aloud	Guided interaction	Thinking aloud	Guided interaction
n	8	8	8	9
Total = **33**				

Table 3. Eating Disorders usability test – Sample B

Immersive								Non Immersive							
Psychologists				Non Psychologists				Psychologists				Non Psychologists			
18-40		40 - *		18-40		40 - *		18-40		40 - *		18-40		40 - *	
M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Total = **16**

Table 4. Semi-structured interviews– Sample C

	Panic Disorders – Agoraphobia	Eating Disorders
Psychotherapists involved in clinical trials	1	3

emerged during *phase 1*. This model of analysis granted a considerable saving of time and of resources since it allowed an easier categorisation of the critical elements deserving special attention. Moreover, the utility increases, considering that the new module is made up by a number of VEs definitely higher than the one previously analysed (*Panic Disorders' - Agoraphobia modules*).

The *usability test* was conducted on 16 subjects (8 immersive mode and 8 non immersive mode) belonging to both sexes aged between 18 and 40 and over 40.
Time per session: 45-55 minutes

The users' sample consisted of psychologists and non psychologists. Specific ***micro-narrations*** for **psychologists and non psychologists** have been used in order to create a more ecological context of analysis.

Phase 3
Modules: Panic Disorders – Agoraphobia / Eating Disorders

Semi-structured interviews were conducted with the 4 psychotherapists involved in the clinical trial: 1 for Panic Disorders – Agoraphobia; 3 for Eating Disorders.

4. Results

4.1 Phase 1

Usability test - Main function of this analysis was the identification of variables useful for a rough elaboration of the usability components deserving major attention in the *phase 2* (Fine Tuning). The results of *phase 2* were then used to tune in the modules with the real context of use and with the specific requirements of the *communities of practice* to which they are destined to.

Specific objects in phase 1 were the 4 VR scenarios composing the Panic Disorders' and Agoraphobia modules (Lift, Underground, Plaza, Supermarket). The interaction in each of the 4 environments was analysed in detail according to 3 dimensions:

- Navigability
- Expected utility

- Contents completeness/graphic appeal

Fifteen days after the usability tests, a focus group was carried out in order to validate what was recorded through the observations. A synthesis of the emerged results follows, stressing out basic observations concerning each of the 4 considered scenarios. The critical surfaced topics have been used to focus the dimensions deserving special attention during *phase 2* and to carry out basic modifications in the course of the designing process, taking into account that the methodological objective consists also – as already stated – in the identification of the requirements of the specific *community of practice* the modules are destined to and not only the needs of a generic sample of users. This is the reason why, for example, some elements identified or perceived in this first phase as 'limits' to the interaction could even represent strong points when considering the specific ethnomethod.

In particular, it seems important to consider some factors influencing and orienting the experience and assessment that subjects gave of it as, for example, expectations about the experiment and about the navigation experience in a VE. In *phase 2* a specific pre-test and post- test interview about expectations was included to better investigate this specific aspect.

Here follows an example of the results and basic modifications suggested in order to improve the environments' usability.

Evaluation - rating: 1-5 scale

4.2 Phase 2

In the phase 2, on the basis of the outcomes of the previous phase, a preliminary functional analysis was carried out, considering each scenario composing the Eating Disorders' VR modules.

Table 5. Example of a usability test's outcome – phase 1

Lift

Indicators	**Test results**	**General evaluation ad comments**
Navigability	▪ The environment is limited but there are good possibilities of exploration ▪ Rotation effect on 'x' axis was ok ▪ Opening the lift door is not intuitive ▪ 'Reset world' and 'level the world' are often used	++
Expected utility	The possibility of being able to move with the lift was disregarded due to the absence of the push button panel inside the elevator	++
Graphic completeness/appeal	▪ Different levels of graphic realism inside and outside the elevator ▪ Necessity to add the 'push button panel' inside the elevator	++ add the 'push button panel' inside the elevator graphic definition to be improved

As underlined by Sutcliffe [23][1] "since VEs are constructed to represent the real world, user tasks should ideally mirror real world actions; however, in practice limitations of technology mean that some compromises have to be accepted. above all considering real requirements of specific users."
In particular, evaluators focused their attention on the presence or absence of features in the following categories.

Lack of haptic feedback. As known, virtual prototypes have no haptic feedback (sense of touch) so the user's presence can pass through representations of solid objects. Following Sutcliffe, we could say that "to mitigate the lack of haptic feedback many applications use visual feedback with collision detection algorithms to prompt users when objects are selectable or have been selected. Problems caused by absence of haptic feedback may be observed with complex manipulations and physical tasks. These problems can be avoided by designing augmented reality in which interactive surfaces are modelled as physical mock-ups, but in many VEs this is too expensive".

Realistic graphics. Sometimes VEs are not able to represent the prototype, and this because most applications are not rendered in photorealistic detail. As Gabbard says, there is some evidence suggesting that people can perform tasks naturally even in absence of detailed visual cues and representations [24]. Nevertheless, we must admit that graphical detail is important for information displays and for tasks when the system environment is visually complex. The same could be said for audio input.

Compatibility with the user's task and domain. The VEs and behaviour of objects should be as similar as possible to the user's expectation of real world objects, of their behaviour, and affordances for task action.

Faithful viewpoints. "The visual representation of the virtual world should map to the user's normal perception, and the viewpoint change by head movement should be rendered without delay".

Navigation and orientation support. "The users should always be able to find where they are in the VE and return to known, preset positions. Unnatural actions such as fly-through surfaces may help but these have to be judged in a trade-off with naturalness".

Clear entry and exit points. "How to enter and exit from a virtual world should be clearly communicated".
Number of tester: 2

General considerations:
Menu/commands:

- In full screen modality it is not possible to access the menu
- Changing environments: by pressing the key "Esc" and by dragging the icon into the browser's window
- The commands' menu is complete. More details are needed about the functions available
- Movements: on the keyboard only go-forward and go-backward movements are allowed

[1] Since we found our results very keen to what Sutcliffe said, we made a large use of his formulation of Nielsen heuristics

Scenarios:

- Movements along the 'z axis' are not continuous. In particular: lowering the height level in the 'go-backward' movement.
- Collision control: with peripheral walls only
- No interaction with objects with the exception of some specific situations. As for the doors, the lack of interaction (possibility to open the door) sometimes causes uselessly navigation
- The world's limits control has not always been implemented

Evaluation - rating: 1-5 scale

Table 6. Example of a functional desk analysis' outcome

Scenario	Control on 'z' axis	Collision control	World's limits	Interaction	Details' quality	Anchorage
Kitchen	+++	no	no	yes	++++	no
Comments: interaction with refrigerator's doors, cupboards, oven by double clicking the 'enter' key (on the keyboard); it is possible to virtually eat the food by double clicking the 'enter' key (on the keyboard): food appears on the table. Graphic details of the objects inside the refrigerator are not perfectly refined. Immersive mode: movements by 'fits and starts'						
Bedroom	++	yes	yes	no	+++	no
Comments: the predominance of the blue colour gives a sense of oppression – no risk of losing the sense of direction also because the room is small. Graphic improvements suggested: curtains, light sources						
Bathroom	++	no	no	no	+++	no
Comments: Texturing can be improved – Movements are rapid – The quality of the sauna's graphic details can be improved – Difficulties in navigation related to the architectural characteristics (staggered walls, partitions) – The scenario is realistic						
Shopping Arcade	++	no	no	no	++	no
Comments: There is no graphic continuity among the shop's walls – Graphics to be improved in the definition of the ceiling – Texturing quality level not homogeneous – Graphic definition of the objects is not homogeneous. Perspective defects with the walls' angles						
Psychologist's room	+++	no	yes	no	+++	no
Comments: movements by 'fits and starts' – texturing and graphic definition not homogeneous – No risk of losing the sense of direction also because the room is tight						
Weighing machine	+++ limited movements	no	yes	yes	+++	no
Comments: Full-screen modality: there are no instructions to enter weight data – The button 'passa' doesn't give feedback						

Sitting room	++	yes (table)	yes	no	++++	no
Comments: difficulties in 'go-backward' movement						
Safe place	+++	no	no	no	++	no
BIVRS	++	no	no	yes	+++	no
Comments: difficulties with the sense of direction due to poor graphic details in the entrance hall						
9 doors' room	+++	yes	no	yes	++	no
Supermarket	+++	yes (shelves)	yes	no	++++	no
Comments: Graphic defect: wrong specular rotation of some images on the shelf						
Gymnasium	+++	no	no	no	++	no
Comments: Graphic not well refined – the scenario is realistic						
Pub	++	no	no	yes	+++	no
Comments: Interaction with the menu on the table. It is possible to 'open' the menu by double clicking the enter key on the keyboard. Chosen food appear on the table – Graphic details can be improved (block out)						
Clothing shop	++	no	no	no	+++	No
Comments: Graphic definition of the dressing room can be improved – the scenario is realistic						
Restaurant	++	no	no	yes	+++	No
Comments: Interaction with the menu on the table. It is possible to 'open' the menu by double clicking the enter key on the keyboard. Chosen food appear on the table – Graphic details can be improved (block out)						
Beach and Pool	+++	no	no	no	++++	No
Comments: Movements are very slow – Graphic details can be improved (block out) – the scenario is very realistic						

Usability test – In the second test session, some indicators were added to the ones previously used in order to evaluate specific cognitive aspects.

Table 7. Example of a usability test's outcome – phase 2

	Psychologists	**Non Psychologists**
Usability	Navigability	Navigability
	Communicative efficacy	Communicative efficacy
	Content completeness Graphic appeal	Content completeness Graphic appeal
	Expectations	
Cognitive aspects	Attitudes	
	Representations	
	Product evaluation	

Kitchen

Navigability	Communicative efficacy	Content completeness Graphic appeal
▪ Indecision about how to start exploration. This seems to be due to the plenty of stimuli: "I can see the oven...I'm going to see if it works...no I want to see the view out there, before" ▪ Tendency to go backward to have a better perspective ▪ Frequent loss of spatial co-ordinates (above all, along the Y axis) +++	▪ Even with aided interaction, the subject has difficulties in interacting with the objects ▪ Difficulty in positioning correctly in front of the objects to try the interaction (food, cupboards) ▪ The possibility of interaction is not perceived: there are no attempts to interact +++	▪ The scenario is judged complete and detailed ▪ Some specific elements like food or pots draw the attention: "The apples seem to follow me, I can always see them" ▪ In general, some elements are better refined than others from a graphical point of view ▪ Some expert users notice the absence of light sources ++++
Immersive mode /non immersive mode : ▪ Immersive mode: difficulties in keeping the same height level in moving forward and backward ▪ Tendency to lower the head ▪ The restart command is often used		

Evaluation of cognitive aspects

Psychologists

Expectations

- Among expected advantages:
  - ➢ Rapidity of access to the patient's dysfunctional representation
  - ➢ Facilities for the therapy: i.e. the outdistancing from the dysfunctional representation
  - ➢ Possibility to modulate some elements in the scenario according to the level of the pathology and with reference to the established therapeutic path
  - ➢ Opportunity to reduce the patient's discomfort
- *Interaction modality*: expectations are oriented towards the possibility to find in the VR situations tasks to perform

Attitudes

- During the interaction most of the psychologists pay attention to the aspects connected with **the emotional assimilability to the painful situations experimented by patients rather than to graphic/technical details**
- The typology of the environments is judged effective. The same for the disturbing effect caused by people represented in the scenarios (social element)
- Some psychologists express perplexity about possible reactions of anxious patients to sudden black-out of the system, loss of directions or excessive slowness in some environments

Representations

- Many of the considerations are referred to the specific theoretical approach of the psychologists interviewed
- The specificity degree of the different scenarios is evaluated very effective with reference to the specific pathologies considered
- Generally speaking, users expect an higher level of interaction

Product evaluation

- Good. The basic concept of the environments is evaluated applicable
- Navigation is not considered intuitive at all but anyway easy upon correct instructions
- Users underline the possibility to improve data collection and therapeutic process monitoring offered by this kind of product
- Modulability and diagnostic applications are considered the strong points
- Users stress out the necessity to make this kind of technology easy accessible

4.3.1 Phase 3

Semi –structured interviews: data collected in phase 1 and 2 were integrated with data collected through semi-structured interviews carried out with the clinical group. Critical usability indicators were identified and a final evaluation was made with strong reference to applicability and use in *real context.*

General information about the use of the scenarios

Patients' selection criteria

Patients were selected according with their pathologies. Female patients aged between 18 and 50 were considered as they represent the most frequent population in the hospital where the clinical group is operative. They could not have psychiatric pathologies.

They had to possess a PC at home to participate in the following telemedicine phase by using the chat modality; for the control group the distance communication tool was the telephone.

Use of the scenarios

The standard protocol foreseeing a sequence of immersive experiences for each pathology was followed. Each researcher carried out the clinical trial with patients affected by all the pathologies considered.

Protocol application

The protocol foresees a first contact with the VEs through the 'safe place' (psychologist's room). This scenario is used during initial session as training module for patients (commands' use and navigation). In the following sessions, patients start with most restricted rooms/environments towards the widest ones.

Expectations of the therapeutic protocol

Expectations were satisfied by the clinical trials that demonstrated the validity of the tool in the framework of a standard therapeutic protocol. Doubts about the acceptation level by patients were disconfirmed: they showed a high degree of involvement, subsequently confirmed in the post-treatment phase.

Protocol main differences in the traditional therapy

VR offers the possibility to monitor the patient's reactions in real time and to measure variations of physiological and psychological reactions after a cognitive reconstruction phase. *"...the patient does not have to imagine the real world: the vividness is the same and stimuli can be controlled."*

Traditional therapy foresees a cognitive reconstruction of dysfunctional thinking processes by using imagination. With the VR therapy it is possible to speed up these processes, because the observation of the patient's experience gives the therapist the possibility to interact actively with the patient. He can describe the mechanism regulating the pathologic behaviour bringing it on a 'meta' level where the therapist can operate "...once I was in the supermarket, I remembered what I saw in my eyeglasses (i.e. headset) and everything my therapist told me"

Usability evaluation

Critical aspects identified in *phase 2* were rated on a 1-5 scale considering the interaction modalities in real context of use.

Critical aspects: Navigability: Axis control – Collision control – World's limits - Anchorage

During the VR therapy the patient is not free to move around: he is accompanied by the therapist that guides him on a specific pathway and operates in order to facilitate the interaction of the patient inside the VR situation. There is no possibility to lose the sense of direction or to try the 'space suspension' experience that could interrupt the continuity of the immersive experience.

Orientation – Adaptation to the VR experience: small rooms (i.e. psychologist's room) have the function of allowing patients **to adapt themselves to the VR experience**. They are also used because of their limits in order to make the patient acquainted with the navigation and with controls.

Final evaluation: ++++

Critical aspect: Interaction – difficulty in positioning correctly in front of the object where the interaction is foreseen

On the basis of the previous experiences (VREPAR Project) it was decided not to allow patients to manage the controls concerning interaction, as it was noticed that patients too frequently used them incorrectly. When patient focuses an object, the mark on the screen allows the therapists to activate the interaction (doors' and cupboards' opening, objects moving). This procedure is aimed at protecting the patient's VR experience allowing an easier monitoring of some pathological processes (i.e. binge eating). Moreover, by displaying a specific positioning in front of the selected objects, a correct visualisation is possible (i.e. food on the table).

Final evaluation: ++++

Critical aspect: Interaction – Absent in the weighing machine room

Considering the specific characteristics of patients who avoid facing real data concerning their own problem, it is up to the psychotherapist to insert data concerning weight (previously collected) while the patient can read his weight on the display while the index of the scale remains unvaried.

Final evaluation: ++++

Critical aspect: Interaction – absent in the Supermarket scenario

There is a lack of interaction in the environment owing to technical reasons. It would not have been cost-effective to make it possible to have an interaction with food which would require relevant graphic adaptations. The clinical observation criterion was **to discriminate between 'anxiogenous pathways' and 'neutral pathways' according to the typology of the products**:

"...we put an anxiogenous department near to a non anxiogenous department so that if you are anxious you can easily move your attention from one department to the other"

Final evaluation: ++++

Critical aspect: difficulties in movements caused by external devices

The navigation experience in the therapeutic situation is easier than the one experienced in the usability tests, as in the clinical phase any difficulty that may occur in controls is mastered and in some cases anticipated by the therapist. A few critical aspect still remain, which are connected with the use of the headset and with the possibility of physical movements in hampered patients

"...we help them with the mouse. It happens in some environments as, for example, in the supermarket, where you have to follow passages or revolve 180° and anyway the patient doesn't feel belittled or clumsy...we make him feel normal"

During the session the therapist can touch the patient to help him in rotation movements characterising the navigation mode in some environments (BIVRS)

"...so you can touch him, for example, in BIVRS you can help me to find the correct position. It is also an emphatic contact: the patient knows that you are there. Sometimes we (therapists) get up and look towards the headset or to the monitor to help them"

Final evaluation: +++

Critical aspect: Graphic appeal

In contrast with the results emerged in *phase 2*, patients affected by eating disorders give no importance to the graphic attractiveness of the environments and this indicator plays a role of minor importance in the context of the therapeutic process. Patients need a very basic representation of the stimulus to reactivate the non-functional behavioural mechanism. The attention they pay to the vividness, the completeness of the scenario, the realism, the graphic details of the stimulus is inversely proportional to the gravity degree of the pathology. If there are serious difficulties in interpreting the environment, the therapist helps the patient.

"...from a clinical point of view, the realism makes no difference: there is no correlation between effectiveness of the therapy and the realism of the environment"

Final evaluation: ++++

4.3.2 Outline of the semi-structured interview

a) Use of the modules

- Can you tell us which were the patients' selection criteria?
- Which modules did you use? With reference to which pathologies?

- As far as you know, during the clinical trial, there have been deviations with respect to the protocol?
- Was the clinical trial brought to conclusion according to scheduled times and modalities?

b) Expectations with respect to the protocol

- What kind of expectations did the therapeutic protocol give rise to? (as for your experience).
  Notes for the interviewer
  - *Clarify that in this case we mean 'integration of VR in the therapeutic session'*
  - *Stimulate references with specific pathologies and examples*
- Did you think about possible resistances of the patients?
- And what about your colleagues involved in the project?
  Notes for the interviewer
  - *Stimulate considerations about possible personal difficulties / resistances referred to the control of the therapeutic session*
- Which are the main changes with references to the therapeutic protocols you usually use?
- How did you think patients should have faced VR during their therapeutic sessions?

c) Usability

c.1) Local interaction with the artefact

- To evaluate the ergonomic aspects of the modules you used, we considered some indicators. We would like to have your opinion about them. We invite you to think about each of them with reference to the entire system. If you like, you can make specific examples
  The interviewer reads the indicators' list (navigability, contents' completeness, etc.) adding a short description. He makes specific reference to the navigation toolbar only with therapists who used scenarios with command menu appearing on the screen
- The patient is not free to interact with objects, but he's guided by the therapist. How is the navigation controlled in this specific case? Which specific commands are controlled by the patient and which ones are controlled by the therapist?
- In your opinion and with reference to the specific pathology you treat, which are the scenarios you judge more useful (and why) and which ones seem to be less effective? What is your 'satisfaction degree'?
- Let's talk now about patients. How much did they seem involved in the different situations?
- Did they seem sensitive with respect to the graphic appeal? And with respect to other indicators? (*the interviewer reads the list again trying to stimulate a possible confrontation with common users)*
- Which was the patient's reaction when a problem connected to the system occurred (i.e. blocks, slowing down, etc.)?

c.2) Interpretation of the situation

- Taking into account the above mentioned considerations, what was, in your opinion, the VR influence during the therapeutic session on:

- Your job, as therapist?
- The patient's behaviour?

- According to you, what do patients think about the introduction of VR in the therapeutic session?

c.3) Definition of the context

- In your opinion, which was the incidence of the use of VR modules on the progress of the therapy?

d) Towards a culture of use

- How do you think other colleagues sharing your same theoretical approach could use the VR in the context of their therapies?
- Do you think that also colleagues with different theoretical approaches could integrate VR in their therapeutic sessions?
- Which are the main steps for a possible professional training for therapists?

5. Conclusion

On the basis of the evaluations carried out, the usability requirements for a correct and effective use of the VEPSY Eating Disorders modules are fulfilled. It was possible to verify that critical aspects according to the classic usability parameters were faced and effectively solved in the context of the clinical application. On the other hand, some lacks revealed as 'plus' when put in the context of the therapeutic framework as in the case of the graphic appeal, that does not influence effectiveness of the VR therapy at all. The VR scenarios have the function to speed up the access to the personal experience of patients affected by specific psychopathologies and the representation of the stimuli functional to the activation of this process does not need to fulfil requirements connected with the realism of the experience intended as focus on the physical characteristics of VEs: "In this sense, emphasis shifts from quality of image to freedom of movement, from the graphic perfection of the system to the actions of actors in the environment"[25]. Through a correct interaction between the therapist and the patient it is possible to anticipate and avoid any problem of orientation and navigation. The use of devices is simplified and the system is accessible.

From a theoretical point of view it is clearly necessary to draw up new methodological criteria for the evaluation of VR usability minimum requirements when the aim is not the perfect realism of the stimuli represented. Starting from the evaluation of the critical level with reference to usability indicators usually applied, the investigation of the real context of use is the fundamental step that can effectively contribute to the optimisation of the whole designing processes together with the effective integration of existing methods and the improvement of usability evaluation's tools that are still too vague for VR applications

At the end of this paper, we can say that the criteria adopted to analyze VEPSY VEs allowed us to achieve the following:

- Recognize the mediated character of every experience of presence
- Conceive the experience of artefacts' use as immersed in a social context and goal-driven
- Stress the component of ambiguity inherent in everyday situations
- Demonstrate how cultural dimensions affect the effective use of VEs.

The research has thus become a moment of construction - and not of simple application - of new tools for the analysis. One of its main features is that it does not have only a descriptive function, but it also contributes to prescribe solutions to make the VEs systems more efficient, to reach, in every specific case, a sufficiently concrete improvement of the whole interactive process, abandoning an artefact-centered perspective or one restricted to the user–artefact interaction with the main focus on functional characteristics only. And developing this perspective will be our engagement for future usability analysis.

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SECTION V

THE FUTURE OF CYBERTHERAPY: NEW SCENARIOS AND APPLICATIONS

The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable... This is not just a "user interface" problem... Such machines cannot truly make computing an integral, invisible part of the way people live their lives. Therefore we are trying to conceive a new way of thinking about computers in the world, one that takes into account the natural human environment and allows the computers themselves to vanish into the background. Such a disappearance is a fundamental consequence not of technology, but of human psychology.... Only when things disappear are we freed to use them without thinking and so to focus beyond them on new goals.

Weiser, 1991

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Cybertherapy
G. Riva et al. (Eds.)
IOS Press, 2004

13 Immersive Virtual Telepresence: Virtual Reality meets eHealth

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Abstract Immersive Virtual Telepresence (IVT) tools are virtual reality *environments combined with wireless multimedia facilities* - real-time video and audio – *and advanced input devices* – tracking sensors, biosensors, brain-computer interfaces. For its features IVT can be considered an innovative communication interface based on interactive 3D visualization, able to collect and integrate different inputs and data sets in a single real-like experience.
In this paper we try to outline the current state of research and technology that is relevant to the development of IVT in medicine. Moreover, we discuss the clinical principles and possible advantages associated with the use of IVT in this field.

1. Introduction

According to the recent "ISTAG SCENARIOS FOR AMBIENT INTELLIGENCE 2010" [1] the evolutionary technology scenarios in support of the Knowledge Society of the 2000s will be rooted within three dominant trends:

- Pervasive diffusion of intelligence in the space around us, through the development of network technologies and intelligent sensors towards the objective of the so-called "*Ambient Intelligence*" (AmI) [2];
- increasingly relevant role of mobility, through the development of mobile communications, moving from the Universal Mobile Telecommunications System (UMTS) "Beyond 3rd Generation" (B3G) [3];
- Increase of the range, accessibility and comprehensiveness of communications, through the development of multi-*channel multimedia technologies [4]*.

The convergence of AmI, 4G and multi channel multimedia technologies manifests itself as the next frontier of ICT (Information and Communication Technology). This convergence stimulates a change in the way health care is carried out. In particular, the result is *eHealth*, a globally distributed process, in which communication and collaboration of geographically dispersed users (patients and/or therapists) play a key role [5, 6].

Within this process, an important role will be played by intelligent environments for health care in which complex multimedia contents integrate and enrich the real space [7]. In particular, we expect the emergence of "*Immersive Virtual Telepresence*" - IVT: in IVT tools, distributed virtual reality (VR) systems are combined with wireless multimedia facilities - real-time video – and innovative input devices – tracking sensors, biosensors, brain-computer interfaces.

The strength of the IVT approach is that IVT can be considered at the same time as a technology, a communicative interface and an experience. These characteristics better clarifies the possible role of IVT in medicine: *a communication interface based on interactive 3D visualization, able to collect and integrate different inputs and data sets in a single real-like experience.*

In this paper we try to outline the current state of research and technology that is relevant to the development of IVT in medicine. Moreover, we discuss the clinical principles and possible advantages associated with the use of IVT in this field.

2. Immersive Virtual Telepresence

2.1 The evolution of IVT

A typical first generation IVT system is virtual reality [8]. In VR, using visual and auditory output devices, the user can experience the environment as if it were a part of the world.

Further, because input devices sense the operator's reactions and motions, the operator can modify the synthetic environment, creating the illusion of interacting with and thus being immersed within the environment.

IVT, however, is not only a hardware system [9]. According to different authors the essence of IVT is the inclusive relationship between the participant and the synthetic environment, where direct experience of the immersive environment constitutes communication [10, 11]. In this sense, IVT can be considered as the leading edge of a general evolution of present communication interfaces like television, computer and telephone. Main characteristic of this evolution is the full immersion of the human sensorimotor channels into a vivid and global communication experience: IVT provides a new methodology for interacting with information [12].

For this reason, next generation IVT systems will have an improved focus on the communication capabilities. A possible future IVT application is *Mobile Mixed Reality* [13], the enhancement of information of a mobile user about a real scene through the embedding of one or more objects (3D, images, videos, text, computer graphics, sound, etc) within his/her sensorial field. These objects may be part of a wider virtual space whose contents can be accessed in different ways and using different media (cellular phones, tablet PCs, PDAs, Internet, etc.).

In general, the IVT perspective is reached through:

- the induction of a sense of "presence" or "telepresence" through multimodal human/machine communication in the dimensions of sound, vision, touch-and-feel (haptics).
- the widening of the input channel through the use of biosensors (brain-computer interface, psycho-physiological measurements, etc.) and advanced tracking systems (wide body tracking, gaze analysis, etc.).

Typically, the sense of presence is achieved through multisensorial stimula such that actual

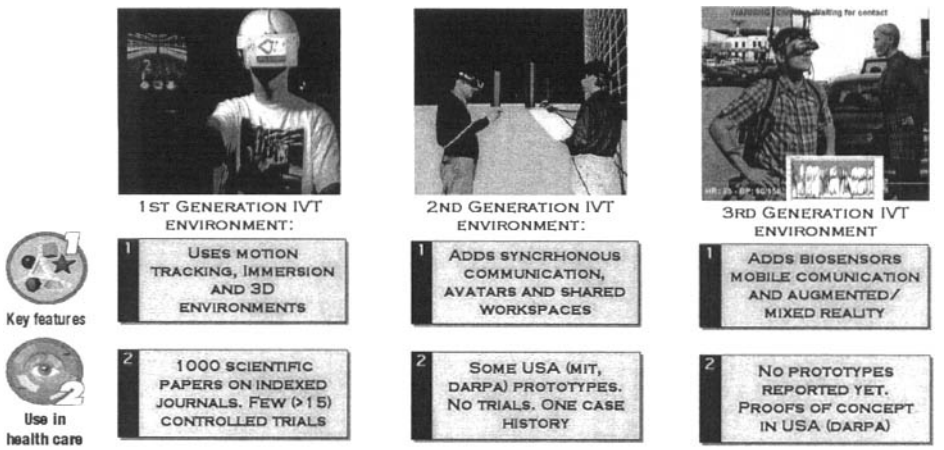

Figure 1. The evolution of IVT

reality is either hidden or substituted via a synthetic scenario, i.e. made virtual through audio and 3-D video analysis and modelling procedures.

In high end IVT systems, multimedia data-streams, such as live stereo-video and audio, are transmitted and integrated into the virtual space of another participant at a remote system, allowing geographically separated groups to meet in a common virtual space, while maintaining eye-contact, gaze awareness and body language. Presence with other people who may be at distant sites is achieved through avatar representations with data about body movement streamed over a high-speed network.

Since e-health is principally involved with the handling and transmission of medical information, IVT has the potential to enhance the e-health experience through the expansion of human input and output channels. The two principle ways in which IVT can be applied are:

a) *as an interface, which enables a more intuitive manner of interacting with information*, and
b) *as an extended communicative environment that enhances the feeling of presence during the interaction.*

These approaches will be strengthened by the development of 3RD generation IVT systems including biosensors, mobile communication and mixed reality.

2.2 IVT System functional architecture

Following these premises, a general system functional architecture for a eHealth IVT systems should includes three main modules:

- The *Visualization Module* will use virtual environments and augmented reality to provide totally new clinical services and interfaces to patients. The research will focus on the characteristics and components of wearable personal virtual reality systems with augmented reality display systems, tracking systems, wireless communications and wearable computing. An essential requirement of IVT personal interface is that it should work wireless, otherwise the patient is tied with

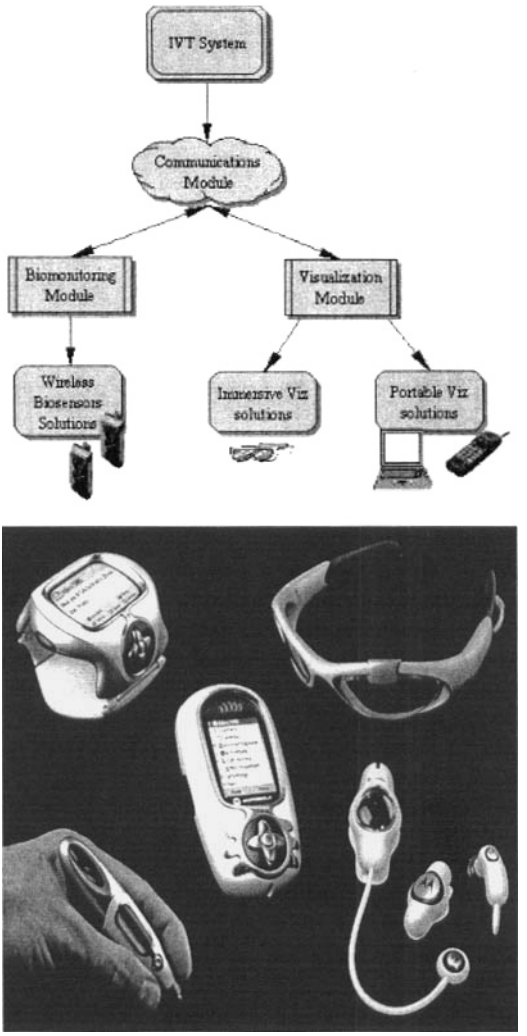

Figure 2. The IVT system functional architecture and a prototype under development by Motorola

cables and the freedom of movement is lost.Wireless communication is needed between components of the system and also between personal augmented reality system and networks services, such as world models and other users or avatars.

- The *Core Module* within the system manages the information flows both internally within the software and externally within the clinical environment to allow remote access and interrogation. The project will develop unique XML messaging services that make the IVT database accessible to external authenticated users. Moreover, the project will develop IVT standards in both client and server configurations making a whole range of medical data available for export and import over clinical

connections. To ensure that the system remains compatible with the latest systems, the latest messaging standards such as HL7[1] will be tracked and monitored.

- The *Biomonitoring Module* will give therapists access to a wide range of physiological data to support highly individual and focused clinical interventions. Biosensors are a neural interface technology that detect nerve and muscle activity. Currently, biosensors exist that measure physiological activity, muscle electrical activity, brain electrical activity, and eye movement. Extracting accurate physiological data from biosensors is often a complex task. In particular, extracting data from different typologies of biosensors will require architecture of great flexibility and the possibility to connected them to different external monitoring devices.

2.3 IVT research

As recently noted by Satava [14], former US Army colonel and head of the DARPA research in this area, the advantages of IVT tools for health care can be summarized in a single word: revolutionary.

However, the research on IVT technologies in the health care sector is moving fast.

In 2002 different US government institutions (i.e. Office of Naval Research, National Science Foundation, and Defence Advanced Research Projects Agency) funded research in this area to the amount of 26 million US$ (Source: DARPA bulletin, 2003). In the same year the European institutions funded research in this field with less that 4 million Euros (estimated from CORDIS database, 2003): less than 1/10 of the US effort.

Up to now, Europe has matched the reduced funds with the creativity of its researchers. In fact, the main applications of virtual reality (1st generation IVT system) in psychological assessment and rehabilitation come from Italian, Spanish, and English institutions.

According to the leading scientific databases the European researchers have the highest number of published papers in this area on peer-reviewed journals (Sources: MedLine, Science Citation Index, PsycLit; Keyword "Virtual Reality"; Accessed: 19 August 2003).

However, the EU research advantage is tightening. In 1997, European researchers authored 72% of all the published papers in this area on peer-reviewed journals. This percentage slipped to 53% in 2002 (Sources: MedLine, Science Citation Index, PsycLit; Keyword "Virtual Reality"; Accessed: 19 August 2003).

Moreover, no European institutions are now exploring the possible use of 2nd generation and 3rd generation IVT tools, exploiting the potential of remote consultations, mobile communication and the use of biosensors. In this specific field no significant effort is made at European level. In US, instead, different companies (Microsoft, Intel) and research institution (MIT, Darpa, USC) are working on the development of prototypes and proofs of concept.

The actual European situation can be explained by the scarce national funding, as well as on the absence of an organization to direct the research with authority. Researchers belonging to the EU run the serious risk of being unprepared, both at a cultural level and at an industrial level, to face the growth that foreign countries are likely to achieve in the vast ICT sector. In this situation, the exigency of a European coordination is of paramount

[1] The Health Level Seven (HL7) Messaging Standard is recognized as the current core message format standard for the electronic exchange of Patient Medical Record Information (PMRI).

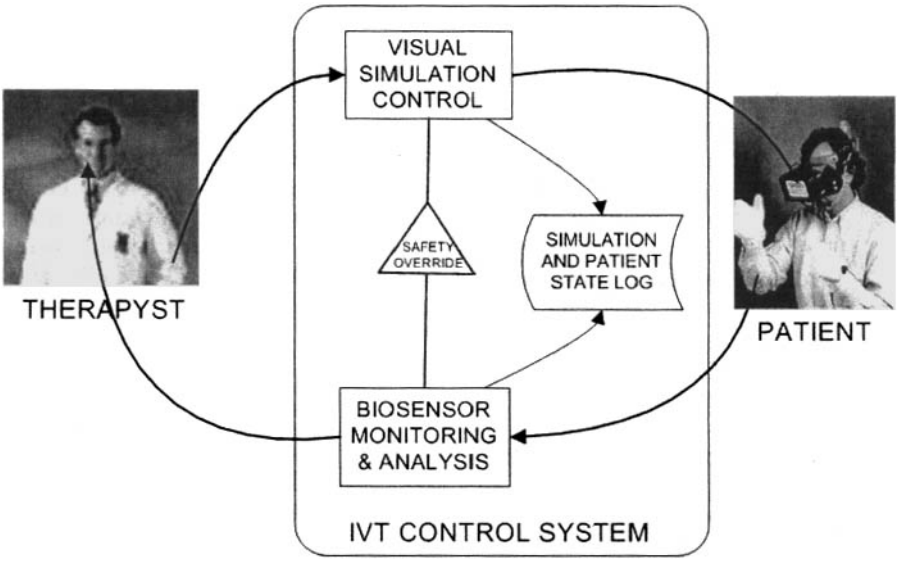

Figure 3. IVT in the patient-therapist relationship

importance, one that is able to promote and lead the development of the research in the application of IVT technologies to health care.

3. Immersive Virtual Telepresence in health care

As we have seen before, IVT is *at the same time a technology, a communication interface and an experience*: a communication interface based on interactive 3D visualization, able to collect and integrate different inputs and data sets in a single real-like experience.

In this sense, the use of Immersive Virtual Telepresence offers many new possibilities to therapists.

Applications of virtual reality – a first generation IVT environment - have been developed in many clinical areas ranging from surgical procedures to the visualization of medical databases. If we check the two leading clinical databases – MEDLINE and PSYCINFO – using the "virtual reality" keyword we can find 829 papers listed in MEDLINE and 693 in PSYCINFO (accessed 17 August, 2003).

However, there is a growing recognition that 2nd and 3rd generation IVT environments will play a broader role in neuro-psychology, clinical psychology and health care education. IVT offers a blend of attractive attributes for therapists. The most basic of these is its ability to create a 3D simulation of reality that can be explored by patients. In many virtual environments, the graphic renderings of people and objects are quite simple, but they are still able to give the visitor a strong sense of presence. In other words, their responses to events and situations within an IVT environment are similar enough to what they would have been in a real environment, thus establishing the possibility of effective treatment and patient support.

The IVT-based treatment differs from traditional therapy in that computer graphics and various display and input/output technologies are integrated *to provide the patient with a sense of presence or immersion*. More in detail, IVT provide a new human-computer

interaction paradigm in which users are no longer simply external observers of images on a computer screen but are active participants within a computer-generated three-dimensional synthetic world [15]. In this world the patient has the possibility of learning to manage a problematic situation. Moreover, IVT offers a high level of control of the experience without the constraints usually found in computer systems. IVT environments are highly flexible and programmable. They enable the therapist to present a wide variety of controlled stimuli, such as a fearful situation, and to measure and monitor a wide variety of responses made by the user. This flexibility can be used to provide systematic restorative training that optimize the degree of transfer of training or generalization of learning to the person's real world environment [16].

Finally, IVT systems open the input channel to the full range of human expressions: in rehabilitation it is possible to monitor movements or actions from any body part or many body parts at the same time. On the other side, with disabled patients feedbacks and prompts can be translated into alternate and/or multiple senses [17].

IVT also offers a strong support to patient mobility. It will enhance patient's compliance by introducing home-based therapeutic exercises and treatment. IVT, provides the patient access to an augmented interface that will take advantage of state-of-the-art biosensors mobile or pervasive computer technology. The immersive nature of IVT and its ubiquity may also provide numerous psychological benefits, such as mood elevation, improved motivation, increased hope for recovery, and an internal locus of control.

4. Conclusions

The use of virtual reality – a first generation IVT environment - supports the possible efficacy of IVT as eHealth platform. In summary the advantages expected by this approach are:

- *Effective Therapy*: as indicated above, IVT offers better significant advantages to the selected diseases that can complement and/or improve existing approaches.
- *Patient Acceptance*: As reported by previous researchers a consistent theme amongst people who suffer from neuropsychological disturbances has been that they would be much more willing to undergo assessment and rehabilitation in a 3D synthetic environment than in a real physical environment.
- *Cost Effectiveness*: Many stimuli for exposure are difficult to arrange or control, and when exposure is conducted outside of the therapist's office, it becomes more expensive in terms of time and money. The ability to conduct exposures of war situations PTSD patients, for example, without leaving the therapist's office would make better treatment available to more sufferers at a lower cost.

Unfortunately, there is still a limited of controlled clinical studies showing significant advantage of IVT over traditional methods. Moreover the lack of coordinated efforts makes most applications just advanced prototypes that have a limited impact on real world health care provision.

Significant efforts are still required to move IVT into commercial success and therefore routine clinical use. Possible future scenarios will involve multi-disciplinary teams of engineers, computer programmers, and therapists working in concert to treat specific clinical problems. It is hoped that by bringing together this community of experts, further stimulation of interest from granting agencies will be accelerated. Information on advances in IVT and eHealth technology must be made available to the health care

community in a format that is easy-to-understand and invites participation. Future potential applications of IVT are really only limited by the imaginations of talented individuals.

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14 The future of Cybertherapy: Improved options with advanced technologies

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Abstract: Cybertherapy is a field that is growing rapidly due to today's technology and information boom. Virtual reality and advanced technologies have been used successfully to in a variety of healthcare issues, including treatment of anxiety disorders and phobias, treatment of eating and body dysmorphic disorders, neuropsychological assessment and rehabilitation and distraction during painful or unpleasant medical procedures. The novel applications of these technologies yield many advantages over traditional treatment modalities, and the disadvantages that accompanied the first trials of virtual reality are quickly being addressed and eliminated. Virtual reality peripherals such as data gloves, physiological monitoring and Internet worlds are swiftly demonstrating their usefulness in cybertherapy applications. Future directions for research include improvements of objective measures of efficacy such as fMRI and physiological monitoring devices, and investigations are being carried out to determine if virtual reality and advanced technologies can be used to treat a broader scope of disorders, including depression, schizophrenia, drug addiction, and autism.

1. Introduction

Cybertherapy can be defined as the use of advanced technologies, such as the Internet or virtual reality, as an adjunct to traditional forms of therapy. Technology can provide visual and auditory stimulus that may be otherwise difficult to generate, creating a new environment in which to engage in therapy. Though only a major area of study for just over a decade, Cybertherapy is quickly becoming an accepted and validated method for the treatment of many different healthcare concerns.

Cybertherapy has lead to significant progress in the treatment of anxiety disorders and phobias, eating and body dysmorphic disorders, neuropsychological assessment and rehabilitation, and distraction during painful or unpleasant medical procedures. Numerous clinicians are actively investigating the use of advanced technologies in other areas of mental health, including using virtual environments for addiction disorders, stress management, depression, schizophrenia, sex offender therapy, social skills training, attention deficit disorder, and many others.

1.1 Benefits of Cybertherapy

Virtual Reality-Enhanced Cognitive Behavioral Therapy (VR-CBT) offers many advantages over traditional treatment for an abundance of disorders. It can reduce the

length of treatment, reduce relapse rates and is often more effective than traditional forms of therapy. By providing a variety of stimuli such as 3D visual, binaural audio, vibratory, tactile and olfactory in an immersive and sometimes interactive manner, virtual reality enhances the therapeutic experience, especially in treatments that traditionally involve imagination.

VR-CBT requires, on average, 8-12 sessions to treat specific phobias. It has been shown in controlled studies to work more effectively with phobias than imaginal therapy (visualization) and as effectively as in vivo (real-life) therapy. Recidivism rates can be reduced and therapeutic effectiveness can be enhanced by adding physiological monitoring and feedback to VR-CBT. Results from a three-year follow up analysis of data from a fear of flying study controlled study [1] indicate that VR-CBT with physiological monitoring results in lower relapse rates than VR-CBT alone.

Virtual reality can also offer new options to patients who are unable to utilize imaginal therapy due to difficulties engaging with a situation, or who are resistant to in vivo treatment due to extreme phobias and anxiety. It is recognized that there is a large percentage of the population (over 80%) that cannot visualize effectively (the anxiety response to a situation is not activated). In addition, many of those suffering from panic or anxiety do not feel that they can approach their feared situation in real life. Virtual reality offers an intermediary step between these two situations. Patients who are resistant or unable to engage with an imagined version of their fear can no longer avoid engagement when presented with the virtual stimulus. However, those who are too afraid to confront a situation in real life are able to practice first in a virtual environment. Through the use of virtual reality, patients have another option for treatment that avoids some of the limitations of traditional forms of therapy.

1.2 Obstacles in the Application of Cybertherapy

There are, nevertheless, a number of concerns related to the use of advanced technologies for healthcare purposes that clinicians must take into consideration. These can include cost, the technological capability of the therapist, side effects in some patients, insufficient realism and presence level in the virtual environment, and the problem of obtaining objective measurements of desensitization.

Until recently, the cost of equipment to treat anxiety disorders topped $150,000, a considerable and sometimes prohibitive cost for most clinicians. However, the development of powerful personal computers (PCs) has reduced the cost dramatically.

Some current virtual reality systems are available for an overall cost of $5,000, including a computer system with updated graphics card and an inexpensive head mounted display (HMD). This cost may still be prohibitive for some individual therapists, but it is certainly a drastic change from the expense of initial systems, and costs are continuing to decline. Though augmenting virtual reality systems with devices such as data gloves is still quite expensive and can add a significant level of complexity to an office-based system, these devices are not always necessary. Additions such as smell, heat, wind or breeze (for driving or heights environments, for example) are effective and do not require a significant investment. Higher end systems, such as the CAVE and Immersadesk, run simulations that require significant technical support and are not yet practical for the therapist's office.

Efforts to increase realism or presence, such as by using airline or automobile seats or by adding tactile augmentation, require custom designs and are therefore products of ingenuity and tenacity on the part of individual researchers.

The operation of PC-based virtual reality programs does require basic computer skills, and the therapist must be willing to invest time to learn these basic operations. Assembling systems requires knowledge of computer peripheral devices and how to appropriately

interface with computers. There are several key technical issues that need to be addressed as research in virtual reality treatment continues. Some patients report that controlling the environment through either the keyboard or mouse is not intuitive and sometimes inhibits immersion in the environment. In addition, since there is no uniform standard for the development of virtual reality software or interfaces, developers use a variety of different software programs, graphics cards, sound cards, etc. This requires that a separate computer system be available for each environment, a prerequisite that most private clinicians cannot afford. In addition, because of the variety of software and hardware utilized, some virtual environments crash with other systems or contain bugs that may inhibit therapeutic efficacy.

Another concern that arises with virtual reality therapy is that a small percentage of the population suffers side effects associated with virtual reality exposure. This cluster of symptoms is called cybersickness, and symptoms can include motion sickness, oculomotor problems, and migraines. Borderline patients, who often have attachment issues, may also fare poorly in virtual reality environments that allow less contact with the therapist, though this can be overcome by using environments where the therapist can enter as an avatar or speak to the patient during exposure. More research needs to be completed to determine appropriateness of virtual reality treatment for individuals with special needs. Although there were initial concerns related to using virtual reality for treatment of schizophrenia, these have not materialized. Four groups who are actively using virtual reality for assessment and treatment have found that issues related to confusion over "virtual worlds" and "real worlds" seem manageable in high functioning schizophrenics [2, 3, 4, 5].

Regarding treatment efficacy, it has been found that virtual reality environments may not seem realistic enough for certain patients because some graphics still have a notable cartoon-like aspect and may not effectively evoke the fear response necessary for desensitization in some groups of patients. Improved and variable scenarios are also needed to increase real-life applicability for the patient. However, this concern has been somewhat lessened by the recent research on presence, which indicates that a highly realistic environment may not be necessary, and, in some cases, may not even be optimal for effective therapy.

While it is clear that self-report measures do not produce the desirable level of accuracy for measurement of treatment effectiveness, and can be colored by a variety of patient and event-specific confounds, it has been shown that heart rate variability, skin conductance, and EEG are useful analogs of absorption and presence. Many therapists who perform traditional treatments such as imaginal exposure or systematic desensitization currently use physiological monitoring. Studies have reported that when the phobic patient's fear structure is activated, autonomic arousal (such as increased heart rate or sweat gland activity) occurs. Physiological monitoring helps to determine if the patient's fear structure is activated and, thus, open to change. It also indicates if the patient is getting "too" aroused (which could indicate flooding), which is not desirable. Finally it shows if the patient has become desensitized to a certain aspect of the phobic scenario and should be encouraged to move on to the next level of the fear hierarchy. A high level of presence and immersion seems to be correlated with faster movement through therapy, a higher level of therapeutic success, and from preliminary data, less recidivism [1].

At present, two systems are necessary to both present visual stimuli and measure physiology. We hope to create future systems that will combine both tasks into an easy-to-use product that makes this form of therapy easier to deliver. An integrated system incorporating a virtual world and physiological monitoring may allow real-time data analysis to occur. The ultimate goal may be to have virtual reality systems that are driven by the patient's own physiology. This will likely include intelligent software that would automatically control the level of difficulty the patient experiences in achieving desired

parameters in training. Newer and less invasive methods to measure patient physiology need to be developed as the current methods are intrusive to some patients and may affect their levels of immersion in the virtual environment.

In summary, it must be acknowledged that the use of virtual reality in the area of mental health is still in its infancy. To further proceed and become a recognized part of therapy, more controlled studies are needed to determine if virtual reality does indeed provide for quicker, cheaper, more efficient treatment.

2. Future Directions

2.1 New Technological Devices

Some virtual reality researchers are investigating the possibility of delivering virtual environments for therapeutic purposes over the Internet, to counteract some of the aforementioned complications of in-office virtual reality therapy. Internet dissemination would allow therapists easy access to new virtual environments and would provide them with a broader selection of options for use in therapy. In addition, therapists would have access to the latest versions of the software, quickly obtaining programming changes to fix glitches in their systems. The possibility of offering virtual reality services to patients (under therapist supervision) in the home has already become a reality, but this practice has yet to become widespread. Internet treatment may become a great asset for some populations, such as patients with agoraphobia or social phobia who have difficulty leaving their homes. Other patients could benefit from occasional Internet-based "booster" sessions after successful completion of therapy for a specific phobia. In addition, Internet-based support may enhance quality of life in those with cancer, AIDS or Alzheimer's who are not always able to venture out to obtain the needed social support.

Exciting new methods are allowing for the introduction of real digitized images into the virtual world. A digital photo can be added to a virtual world using readily available, inexpensive digital cameras (Microsoft sells an inexpensive digital camera for about $30).

Some of the more expensive and advanced digital cameras are able to provide a 360-degree view of the surrounding environment, adding tremendous flexibility to the construction of virtual environments. As a result of advances in the entertainment and consumer products arena, adding digitized representations of real-world environments is now within reach of individual users.

These techniques have the potential to help treat Attention Deficit Disorder, Social Anxiety Disorder, and Public Speaking Anxiety. By including photographs of a child's actual classroom, the therapist can work with them to improve concentration skills during tests and assignments. In addition, working with photographs of classmates, co-workers or family members, patients can develop social skills in the safety of a Virtual Environment before attempting interaction in an Internet world or the real world. Incorporating photographs into VEs can also help to create a realistic audience for a patient to practice giving a presentation, repeating the exercise until the activity is no longer frightening.

Other promising peripheral devices exist, for example, the "data glove" and the "force-feedback" glove. The data glove is a flexible glove with tracking and movement sensors that is worn on the hand. It allows for tactile interactions in the virtual environment, giving the user the ability to grasp and manipulate virtual objects. This technology can be used to help desensitize patients to disturbing tactile stimuli, to distract them from an unpleasant medical procedure, or to increase presence in a virtual environment.

Force-feedback is a much more complex "glove" that simulates surface features and textures in the virtual world. In picking up or pushing a heavy virtual object, the force-

feedback glove produces a resistance that reinforces the user's perception that a heavy object has been encountered. A number of applications for this glove are under investigation, including rehabilitation therapy and range of motion exercises for patients with injuries or disabilities and treatment of repetitive behaviors in Obsessive Compulsive Disorder patients. However, these systems are expensive, and, thus far, no large clinical trials have been implemented using this technology.

Future developments in virtual reality technology will include systems that allow the therapist to accompany the patient into the virtual world. To a certain extent this can currently be accomplished through the use of Internet-based virtual worlds. In an Internet virtual world, both patient and therapist log on to a particular website and adopt a preferred "avatar," a virtual representation that allows the user anonymity. Through their avatars, the therapist and client can explore different worlds offered on the website or interact with other visitors who have adopted their own avatars. One use of these Internet-based virtual worlds is in the treatment of social phobia. After practicing with the therapist in a closed system, the client can visit a virtual world populated by other avatars, initiate conversations, and obtain feedback from other avatars in real time audio through the use of a simple microphone. Internet-based virtual worlds are also currently being used in the treatment of agoraphobia to expose the patient to unfamiliar worlds different than those the clinician can provide in the office setting.

In addition, as video games continue to improve in realism and flexibility, they are offering new tools for psychotherapy. The current version of "Midtown Madness" by Angel Studios/Microsoft is an inexpensive off-the-shelf video game that is currently being used for driving simulation at the VRMC. Other clinics are also beginning to use this system with positive results [6]. These driving simulations apply to a wide variety of social, medical, and psychological performance applications including rehabilitation, fear desensitization and skill assessment. Another video game, "Half-life," by Valve software, offers a fully-mouse-driven 360-degree realistic world, parts of which might be useful for treating war-related PTSD. In addition, modules for specific videogames that are available through the Internet (such as Max Payne) are easily adaptable, and such things as spiders and other creatures can be programmed into the world to help treat phobias and other anxiety disorders [7].

Recently, new virtual reality hardware is being developed that is compatible with functional Magnetic Resonance Imaging (fMRI) machines. These new head mounted displays allow researchers to observe the brain in action through fMRI. Several studies have been completed using this new hardware, including one by Graham et al [8] that examined navigation skills in a virtual reality environment, and a second study examined subjects' sense of presence in immersive virtual environments [9]. In addition, a presentation at the CyberTherapy 2004 conference will discuss the results of a study to examine the brains of nicotine-dependent subjects through fMRI use during virtual reality cue exposure [10]. This new concept has countless applications including investigation into which areas of the brain are activated during specific tasks and what differs between normal brains and those with mental disorders.

2.2 New Applications

As technology advances, and more disorders are being effectively treated through the utilization of these developments, research continues into ways in which the boundaries of cybertherapy can be expanded. One interesting new development in the field is the use of virtual environments for special education purposes. Brown and others at the Virtual Reality Applications Research Team (VIRART) are developing the Learning in Virtual Environments program (LIVE) a new experiential and communication tool at a special

school in Nottingham. They are measuring how skills learned in a virtual world transfer to the real world [11].

Other exciting developments in virtual reality include studies into how people interact in virtual worlds. The Collaborative Virtual Environments (COVEN) project, funded by the European Commission, focuses on the development of shared or collaborative virtual environments, bringing together expertise from human factors, networked virtual reality, computer graphics, human computer interaction, and telecommunications infrastructure. COVEN looks at network requirements for the support of such shared virtual worlds [12].

In addition, Bobick and others from MIT are collaborating to produce The KidsRoom, "a perceptually-based, interactive, narrative playspace for children" [13]. In this world, sound effects, music, narration, light, and images are used to transform a normal child's bedroom into a fantasy land where children are guided through a reactive adventure story" [13].

Along the same lines, Pandzic, Capin, Thalmann, & Thalmann [14] from the MIRALab-CUI are creating the Virtual Life Network (VLNET), a group that studies how humans react and interact with virtual worlds and attempts to devise more naturalistic methods for this interaction. In this setting, autonomous virtual actors can be introduced into the environment for any variety of tasks or purposes. Slater devised a series of experiments where three individuals who had never met were required to collaborate in order to carry out tasks in the virtual environment [15]. Group dynamics and interpersonal interaction were observed, with many human emotions (i.e. embarrassment) being generated from the required interaction.

Another new area of research for Virtual Reality in healthcare is the treatment of substance abuse through cue exposure [16, 17]. In this application, craving cues are presented to the patient in a virtual environment. This causes arousal in the patient, which eventually subsides through repetition of exposure. Virtual reality offers an advantage over traditional means of exposure (photographs, video or real life) because it is realistic enough to evoke a response in the patient, but does not allow the opportunity for them to succumb to temptation.

Virtual reality is also currently being investigated to improve quality of life for those suffering from chronic or terminal illness, such as cancer. Some patients suffer great anxiety and distress due to nausea, vomiting, and other chemotherapy-related side effects, and as a result prematurely discontinue treatment, delay treatment, or receive smaller dosages of chemotherapy. If a patient experiences side effects during chemotherapy, they are likely to begin developing anticipatory anxiety associated with each subsequent treatment. Though certain studies have shown videogames, relaxation, and guided imagery to be helpful in reducing distress and serving as a distraction technique [18, 19], these interventions are not effective for all patients. A study by Hoffman et al [20] demonstrates that the immersive, interactive nature of virtual reality enables more individuals to remain engaged and distracted from pain than videogames.

A study performed by Schneider & Workman [21] used VR exposure to reduce anxiety in children during their chemotherapy procedure, with eighty-two percent of the participants indicating that chemotherapy completed during VR was not as distressing as previous treatments without VR. Self-report measures of anxiety and distress were also greatly reduced. A follow-up study by Schneider et al. [22] that involved women receiving chemotherapy for treatment of breast cancer also found VR to be an effective intervention during chemotherapy.

A virtual environment developed by Giuseppe Riva of the Istituto Auxologico Italiano to treat eating disorders has also now been adapted to treat obesity. The environment allows patients to experience their body shape in a different context, providing

the ability to morph and view their bodies as a separate entity. This alternate mode of engagement with body image and food has resulted in effective weight loss and body image satisfaction. In several studies, obese patients fare better with virtual reality treatment then traditional cognitive-behavioral and nutritional treatment [23].

In developing new virtual reality tools, it is important to keep several concepts in mind. Existing therapeutic concepts should form the basis for the construction of virtual worlds. Virtual reality technology must be understood in light of existing science and established paradigms. The application of virtual reality in relation to existing therapeutic approaches and a consideration of the costs of using this technology need to be central in assessing the clinical applications of virtual reality. Multi-disciplinary teams of experts can be very helpful in the development and delivery of virtual reality systems.

3. Conclusion

The future of virtual reality therapy includes treatment of a wide variety of disorders aside from those currently treated such as anxiety disorders and phobias, eating and body dysmorphic disorders, neuropsychological assessment and rehabilitation, and distraction from medical procedures. Future areas may consist of treatment of addictions, depression, attention deficit disorder, stress management, and social skills training. Web-based resources for virtual reality practitioners are currently available and are in continuous development. Input on such topics as clinical protocols, equipment updates and purchases, ethical issues, and the newest research findings can be easily accessed using the Internet.

Training for virtual reality therapists may also become available through the Internet, making it possible for interested individuals throughout the world to participate.

Virtual reality therapy has made initial progress in treating a variety of mental health disorders, but there is more work to be done in a number of areas including the development of easy to use and more affordable hardware and software, the development of objective measurement tools applicable with virtual reality technology, the issue of side effects for some patients, and more controlled studies to evaluate the strength of virtual reality therapy in comparison to traditional therapies. Wider dissemination of the technology will encourage the industry to develop tools in response to user needs.

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